United States
Department of
Agriculture

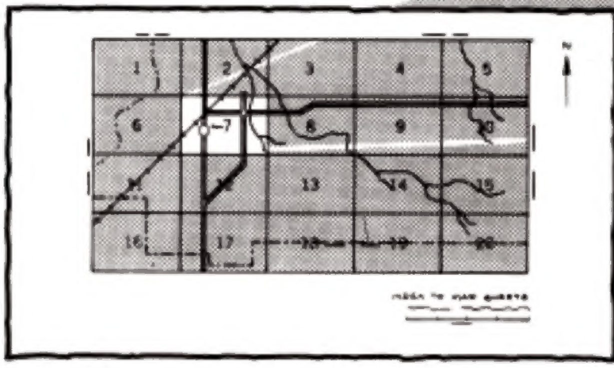
Soil
Conservation
Service

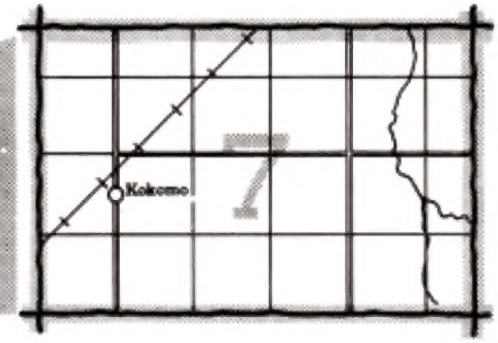
In cooperation with
the University of Nebraska,
Conservation and
Survey Division

Soil Survey of Nemaha County, Nebraska

HOW TO USE

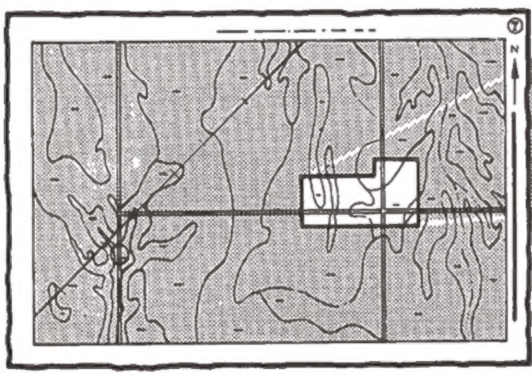
1. Locate your area of interest on the "Index to Map Sheets"

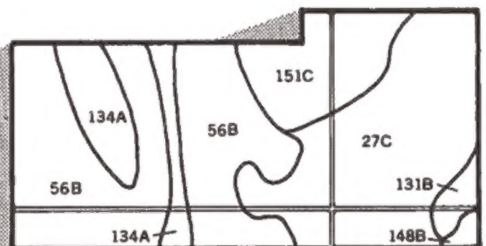




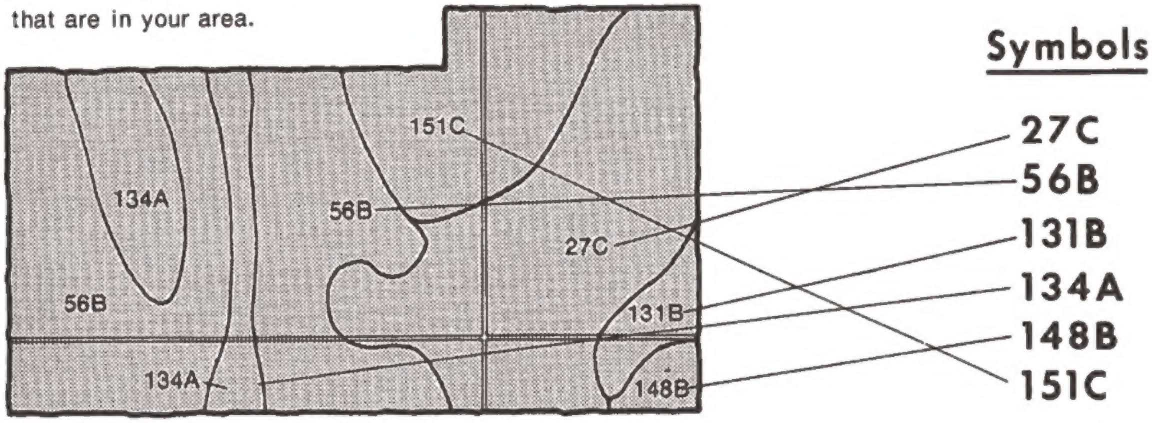
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



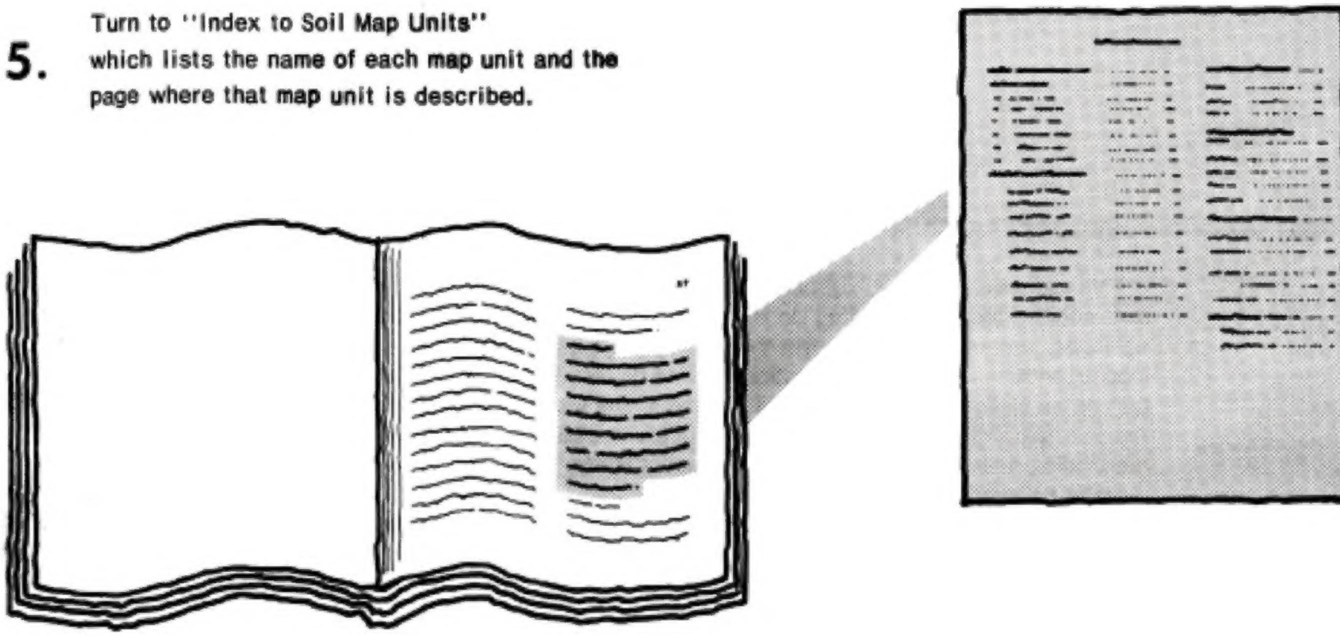


4. List the map unit symbols that are in your area.

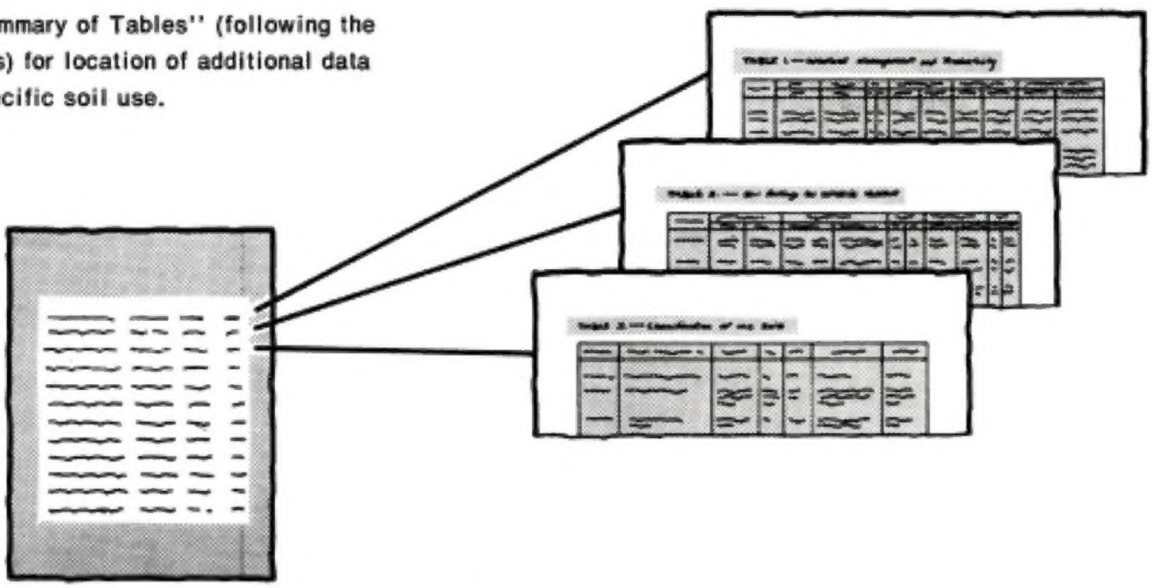


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Nemaha Natural Resources District. The Nemaha County Board of Commissioners and the Nemaha Natural Resources District provided financial assistance for this survey. Major fieldwork for this soil survey was completed during the period 1979 to 1982. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Corn and wheat in an area of Nemaha County where the soils are assigned to the capability subclass IIIe. Terraces, contour farming, and grassed waterways are needed on these soils.

Contents

Soil Series

Issued December 1985

Index to Soil Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Nemaha County, Nebraska. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Sherman L. Lewis

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State Conservationist
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Soil Survey of
Nemaha County, Nebraska

By Donald E. Kerl, Soil Conservation Service, and
Monte Babcock, University of Nebraska, Conservation and Survey Division

United States Department of Agriculture, Soil Conservation Service
In Cooperation with
the University of Nebraska, Conservation and Survey Division

NEMAHA COUNTY is in the southeastern part of Nebraska (fig. 1). It is bordered on the south by Richardson and Pawnee Counties, on the west by Johnson County, on the north by Otoe County, and on the east by the Missouri River. It has an area of 264,717 acres, or 413.62 square miles. Auburn, the largest town, is the county seat.

Agriculture is the main economic enterprise in Nemaha County. Farming and agribusiness are the leading occupations. Most areas are cultivated, but some small areas are used for pasture. Corn is the main crop. Grain sorghum, soybeans, wheat, and alfalfa are other important crops. They provide feed for livestock and cash income.

Loess, alluvium, and glacial till cover most of the county. The soils that formed in glacial till are in the southwestern part of the county. Erosion is the main hazard on the upland soils. The major rivers in the county are the Missouri and Little Nemaha Rivers. The uplands are dissected by several stream systems—Rock, Higgins, Buck, and Honey Creeks in the north; Muddy, Little Muddy, and Long Branch Creeks in the southwest; and Hughes, Indian, Jivers, and Whiskey Run Creeks in the southeast. The soils in the stream valleys are silty and clayey.

The valley along the Missouri River makes up about 8 percent of the county. The soils in the valley formed mainly in silty, clayey, or sandy alluvium. The wetness from a seasonal high water table is the main limitation; and flooding, which ranges from rare to frequent, is the main hazard.

This survey updates the soil survey of Nemaha County published in 1916 (*3*). It provides additional information and larger maps, which show the soils in greater detail.

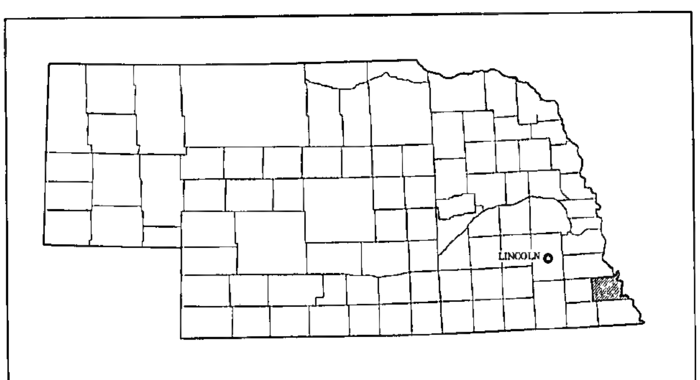

Figure 1.—Location of Nemaha County in Nebraska.

General Nature of the County

This section provides general information about Nemaha County. It describes early history and population; climate; geology; ground water; physiography, relief, and drainage; transportation facilities and markets; and farming.

Early History and Population

Nemaha County was settled in 1853, and the area became a county in 1855. In 1854, the first permanent settlement was established, at Brownville. The area was previously inhabited mostly by the Otoe Indians. Pioneers moved to the area primarily to obtain land. Under the Pre-emption Act of 1841, land could be

purchased for a dollar and a quarter an acre after the farmer had cultivated it for 1 year. Under the Homestead Act of 1862, the farmer owned the land after working it for 5 years. Later, under the Timber Culture Act of 1873, 160 acres could be claimed after trees were planted on one-fourth of this acreage. Early settlers avoided tableland and kept close to the valleys. They endured many hardships, such as shortages of food, fuel, building materials, and transportation facilities. Winters were severe, disease took its toll, and grasshoppers frequently ruined the crops. The worst drought periods were from 1880 to 1900 and during the "dirty thirties," from 1930 to 1940. The first railroad in the county was established in 1870.

According to census figures, the population of Nemaha County reached 14,952 by 1900 and decreased to 10,973 by 1950 and to 8,098 by 1980. The population of Auburn is about 3,482.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

The typical pattern of climate in Nemaha County is one of cold winters and long, hot summers. Heavy rains occur mainly in spring and early in summer, when moist air from the Gulf of Mexico interacts with the drier continental air. The annual rainfall is normally adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Auburn in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 28 degrees F, and the average daily minimum temperature is 17 degrees. The lowest temperature on record, which occurred at Auburn on January 12, 1974, is -22 degrees. In summer the average temperature is 75 degrees, and the average daily maximum temperature is 88 degrees. The highest recorded temperature, which occurred on July 14, 1980, is 110 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 34 inches. Of this, 25 inches, or more than 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 6.44 inches at Auburn on July 6, 1951.

Thunderstorms occur on about 48 days each year, and most occur in summer.

The average seasonal snowfall is about 27 inches. The greatest snow depth at any one time during the period of record was 26 inches. On an average, 25 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 13 miles per hour, in spring.

Tornadoes and severe thunderstorms occur occasionally but are local in extent and of short duration. They cause damage in scattered areas. Hailstorms occur at times during the warmer part of the year, but the hail falls only in small areas.

Geology

The bedrock underlying Nemaha County consists generally of horizontally layered rocks, principally marine limestone and shale. The oldest formations are Pennsylvanian, and the youngest are Permian.

The Pennsylvanian Formation is the uppermost bedrock in about the northern third of the county, on the bluff line and the bottom land along the Missouri River; in the valley along the southern two-thirds of the Little Nemaha River; and along the western edge of the county, near the county line. The uppermost bedrock in the rest of the county consists of Permian rocks.

The Pennsylvanian rocks crop out on the bluffs along the Missouri River and on the south side of the valley along the Little Nemaha River, south of Nemaha. The Permian rocks crop out on either side of the valley along the Little Nemaha River and along Indian Creek, Hughes Creek, Willow Creek, and Long Branch, in the southwestern corner of the county. They also are exposed in other areas (T. 5 N., R. 13 and 14 E., and the southern part of T. 6 N., R. 13 and 14 E.).

Overlying the consolidated Pennsylvanian and Permian rocks are unconsolidated Pleistocene sediments. These deposits consist of glacial till, generally an unstratified, unsorted, heterogeneous mixture of clay, sand, gravel, cobbles, and some boulders. Overlying the till are remnants of the Illinoian-age sediments that range from clayey to sandy and Peorian loess, which is the material at the surface throughout much of the county.

Numerous streams extend to almost all parts of the uplands. Their channels occupy small valleys that cut into the till and loess mantle. The major drainage pattern in the county is characterized by broad valleys incised in the loess, till, and alluvium. The major streams cut meandering channels in the alluvial fill, and channel

straightening has resulted in deeply cut channels that have steep, eroding sides.

Ground Water

Supplies of ground water for domestic use and livestock generally are obtained from the sand and gravel deposited within the glacial till, terraces, and alluvial deposits. In some parts of the county, ground water is obtained from bedrock. Not all wells drilled into the bedrock can yield adequate supplies of water, however, because of the restricted permeability of the rocks. The water obtained from the more deeply buried bedrock could be highly mineralized. As a result, many of the inhabitants of the county must rely on ground water supplies from the unconsolidated material over the bedrock.

In many areas throughout the county, an adequate water supply is not available for municipal and domestic use and for livestock because the water-bearing Quaternary sand and gravel deposits are either thin or do not occur and because the water from the bedrock is highly mineralized.

The chemical quality of the ground water in most areas is suitable for domestic use and livestock. The water generally is hard and, in some areas, contains high concentrations of dissolved iron and manganese. Ground water can be contaminated by drainage from feedlots, septic tanks, or other areas of waste disposal. Domestic wells should be tested for contamination occasionally. When a domestic well is installed, the water should be tested before it is connected to the water system. Contamination tends to be more common in the shallow wells than in the deep wells.

Ground water for irrigation is limited. There are 31 irrigation wells registered in the county. Most of these wells are in the northwestern part of the county.

Physiography, Relief, and Drainage

Nemaha County is in the glaciated part of the Great Plains physiographic province. It is a dissected glacial plain, but only small remnants of the original till plain remain. These are on the highest divides. The gently sloping to very steep landscape formed through geologic erosion of the glacial plain. Materials have been added and modified by cycles of sedimentation, erosion, and soil formation. Erosion shaped the uplands and the continuous strips of bottom land. The uplands are the most extensive feature of the landscape. The strips of bottom land include the low areas adjacent to streams where soil material was deposited.

Relief ranges from nearly level to very steep. Because of the headwater advances of the numerous small drainageways, the nearly level upland areas are small and, in places, irregular in shape. The rest of the county consists of a succession of ridges, sloping areas, and valleys. The ridges are rounded and gently sloping; the sloping areas range from moderately sloping to very steep; and the valley bottoms are nearly level.

Long, gradual slopes on the north side of stream valleys and short, steep slopes on the south side characterize the uplands. The small drainageways are generally shallow, but in places they are sharply cut and have short, steep grades. The steepest slopes in the county are on uplands. Other steep areas adjoin the bottom land along some streams. Most of these areas are narrow strips. The width of the bottom land ranges from a few rods along the smaller streams to nearly 2 miles along the Little Nemaha and Missouri Rivers.

Elevation ranges from about 1,310 feet above sea level on the upland divide west of Johnson to 870 feet in an area in the southeastern corner of the county along the Missouri River.

Most of the surface water in the county drains in a southeast direction. The four principal streams are the Missouri and Little Nemaha Rivers and Muddy and Long Branch Creeks. The Little Nemaha River flows southeastwardly across the central part of the county and receives most of the surface runoff.

Transportation Facilities and Markets

U.S. Highway 73-75 extends north and south through the central part of the county. U.S. Highway 136 extends east and west through the central part. State Highway 105 extends north and south through the western part. State Highway 67 extends east across the northern part of the county to Peru, then south through the eastern part. All towns in the county are connected by paved state highways or by paved or graveled state spurs and graveled county roads. Graveled or improved dirt roads, which are maintained by the county, are along most section lines.

A few railroad lines serve the county. One enters the county west of Johnson and runs through Johnson and ends at Auburn. Another enters the county north of Peru and runs through Peru and Brownville. Another enters the county in the northwest corner and runs southeast through Brock to Auburn, then south through Howe. A branch line connects to this railroad north of Auburn and runs north through Julian.

Excellent markets for farm produce are available in the county and in adjacent counties. Most of the towns in the county have grain elevators, where grain is bought and shipped to large markets. Brownville has excellent facilities for loading grain onto barges for movement down the Missouri River to worldwide markets.

Farming

According to the Nebraska Census of Agriculture, there were 755 farms in Nemaha County in 1969, 720 farms in 1976, and 710 in 1980. This downward trend is

mainly the result of an increase in the size of the farms. The average size is about 340 acres.

The number of cattle is rather constant, about 27,000. The number of hogs was 36,677 in 1969 and 54,000 in 1981. These figures indicate a large increase in the number of hogs.

The kinds of crops grown and their acreage have been fairly constant in recent years, except for a large increase in the acreage used for soybeans. Corn was grown on 47,439 acres in 1969 and 59,800 acres in 1981. Sorghum was grown on 21,044 acres in 1969 and 19,400 acres in 1981. Soybeans were grown on 18,413 acres in 1969 and 72,000 acres in 1981. Wheat was grown on 16,928 acres in 1969 and 29,100 acres in 1981. Alfalfa was grown on 9,628 acres in 1969 and 8,600 acres in 1981. Crops were grown on a total of 183,091 acres in 1969 and on about 200,000 acres in 1981. This increase is partly the result of the conversion of wooded and pastured areas along drainageways to cropland.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some soil boundaries and soil names in this survey do not fully match those in the surveys of adjoining counties that were published at an earlier date. Differences are the result of changes and refinements in series concepts, different slope groupings, and the application of the latest soil classification system.

Descriptions of Associations

1. Wymore Association

Deep, nearly level to gently sloping, moderately well drained, clayey and silty soils formed in loess; on uplands

This association consists of soils on ridges, divides, and side slopes along intermittent drainageways on some of the highest uplands in the county. Slopes range from 0 to 7 percent.

This association occupies about 52,149 acres, or 20 percent of the county. It is about 80 percent Wymore soils and 20 percent minor soils (fig. 2).

Typically, the surface layer of the Wymore soils is very dark brown, friable silty clay or silty clay loam about 7 inches thick. The subsoil is about 35 inches thick. It is mottled. The upper part is very dark grayish brown, firm silty clay. The next part is dark grayish brown, very firm silty clay. The lower part is grayish brown, firm silty clay loam. The underlying material to a depth of more than 60 inches is light brownish gray, mottled silty clay loam. In some areas, such as small grassland areas and areas next to drainageways, the silty clay loam surface layer is thicker and darker.

Minor in this association are Sharpsburg, Pawnee, and Nodaway soils. Sharpsburg soils are on the higher, more convex ridges. They are less clayey than the major soils. They do not have a perched water table. Pawnee soils are on side slopes below the Wymore soils. They formed in till. Nodaway soils are in upland drainageways or in stream channels and old stream meanders. They are stratified throughout and contain less clay than the Wymore soils.

Farms in areas of this association are diversified. They are mainly a combination of cash-grain and livestock enterprises. Most of the association is cultivated. The steeper areas along stream channels, areas of the more eroded soils, and small, odd-shaped areas are commonly used for pasture. The main cash-grain crops are grain sorghum, wheat, soybeans, and corn. Cattle are pastured on crop residue in the winter, and some of the cash-grain crops are used to fatten cattle and hogs. Alfalfa is grown as a forage crop. The supply of well water is limited in some areas, but areas where well water is unavailable generally are served by rural water districts. Farm ponds and streams furnish some water for livestock.

Erosion is the principal hazard in cultivated areas. The wetness caused by a perched water table in the spring and the droughtiness caused by insufficient rainfall are limitations in some cultivated areas. Measures that maintain fertility and good tilth and that conserve moisture during dry periods are needed. Erosion can be controlled by contour farming, terracing, grassed waterways, and a conservation tillage system that leaves all or part of the crop residue on the surface. In areas used for pasture, measures that maintain a good cover of grasses and control brush invasion are the main management needs. Applications of fertilizer may be needed to maintain fertility. Brush can be controlled by mechanical and chemical means. Forage production can be increased by rotation grazing.

2. Sharpsburg Association

Deep, nearly level to strongly sloping, moderately well drained, silty soils formed in loess; on uplands

This association consists of soils on divides, ridgetops, and side slopes along intermittent drainageways. It is

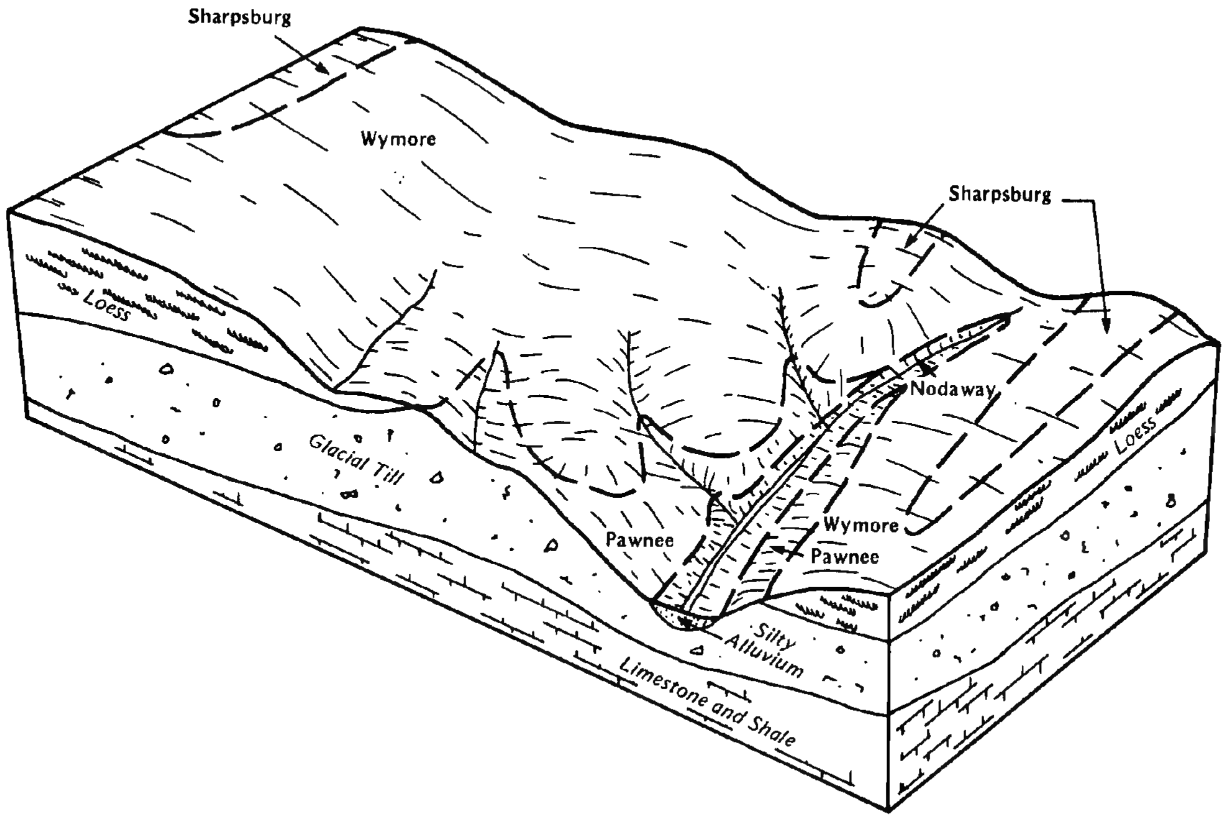

Figure 2.—Typical pattern of soils and parent material in the Wymore association.

dissected by many small waterways. Slopes range from 0 to 11 percent.

This association occupies about 49,194 acres, or 19 percent of the county. It is about 76 percent Sharpsburg soils and 24 percent minor soils (fig. 3).

Typically, the surface layer of the Sharpsburg soils is black, friable silty clay loam about 7 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 11 inches thick. The subsoil is firm silty clay loam about 31 inches thick. It is dark brown in the upper part and dark brown and mottled in the lower part. The underlying material to a depth of more than 60 inches is brown, mottled silty clay loam.

Minor in this association are Judson, Nodaway, Gymer, and Colo soils. Judson soils are on foot slopes, on stream terraces, and in areas adjacent to streams and intermittent drainageways. They are dark to a depth of more than 24 inches. Nodaway soils are along intermittent drainageways and on bottom land along streams that cross the association. They are more silty and more stratified than the Sharpsburg soils. Gymer soils generally are on side slopes and are slightly lower on the landscape than the Sharpsburg soils. Also, they are redder and slightly more clayey. Colo soils are on bottom land. They are very thick and dark. They are somewhat poorly drained and have a seasonal high water table.

Farms in areas of this association are mainly cash-grain enterprises. A few areas are pastured. The main crops are corn, grain sorghum, soybeans, wheat, and alfalfa. Cattle graze the pastures and winter on crop residue. Rock quarries in some areas of this association supply agricultural lime and crushed rock for road surfacing. Some areas have a limited supply of well water. In most areas, however, water is supplied by rural water districts.

Erosion is the main hazard in cultivated areas. It can be controlled by terraces, contour farming, grassed waterways, and a conservation tillage system that maintains a significant amount of crop residue on the surface. These measures also conserve moisture and improve tilth. In intensively cropped areas, applications of fertilizer may be beneficial. In areas managed for pasture, erosion and overuse are the main management concerns. Proper stocking rates help to control erosion and help to keep the pasture in good condition. Brush can be controlled by timely mechanical and chemical means.

3. Nodaway-Zook-Ackmore Association

Deep, nearly level and very gently sloping, moderately well drained to poorly drained, silty soils formed in alluvium; on bottom land

This association consists of soils on bottom land. Some areas are dissected by creek channels. Slopes range from 0 to 4 percent.

This association occupies about 37,559 acres, or 15 percent of the county. It is about 24 percent Nodaway soils, 20 percent Zook soils, 14 percent Ackmore soils, and 42 percent minor soils.

Nodaway soils are nearly level and very gently sloping or are channeled. They are moderately well drained. Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is very dark grayish brown and grayish brown in the upper part and very dark gray and grayish brown in the lower part.

Zook soils are nearly level and are poorly drained. Typically, the surface layer is black, friable silty clay loam or silt loam about 5 inches thick. The subsurface layer is about 23 inches thick. It is black and very dark gray, firm silty clay loam in the upper part and very dark gray, very firm silty clay in the lower part. The subsoil is very dark gray, mottled, very firm silty clay about 10 inches thick. The underlying material to a depth of more than 60 inches is dark grayish brown, mottled silty clay loam.

Ackmore soils are nearly level and are somewhat poorly drained. Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The underlying material is dark grayish brown and very dark gray, stratified silt loam and silty clay loam about 18 inches thick. A buried horizon of black, friable silty clay loam about 19 inches thick is at a depth of about 25 inches. Below this to a depth of 60 inches or more is dark grayish brown, mottled silty clay loam.

Minor in this association are Judson, Wabash, and Kennebec soils. Judson soils are on stream terraces and foot slopes. They are not flooded. Wabash soils are in wide bottomland areas similar to those of the Zook soils. They are very poorly drained and contain more clay than the Zook soils. Kennebec soils are in wide bottomland areas and near old stream channels and are moderately well drained. They contain less clay than the Zook and Ackmore soils.

Farms in areas of this association are principally cash-grain enterprises. Livestock are sometimes pastured on crop residue and on grasses in areas where the soils are too wet for cultivation. Wooded areas are common. Some areas are irrigated. The main crops are corn, grain sorghum, soybeans, and wheat.

Wetness and flooding are the main concerns in managing cultivated areas. Planting may have to be delayed in spring. Planting row crops in the same direction as the prevailing slope improves surface drainage. Land grading and leveling also improve drainage. In places surface ditching may be feasible. In intensively cropped areas, limiting fieldwork when the soils are too wet and applying fertilizer help to maintain tilth and fertility. Proper water management is needed in irrigated areas. In pastured areas deferred grazing when the soils are too wet and proper stocking rates improve forage production.

4. Pawnee-Nodaway-Gymer Association

Deep, nearly level to strongly sloping, moderately well drained and well drained, clayey, loamy, and silty soils formed in glacial till, alluvium, and loess; on uplands and bottom land

The association consists of soils on ridgetops and hillsides which are dissected by bottom land. Slopes range from 0 to 11 percent.

This association occupies about 36,553 acres, or 14 percent of the county. It is about 32 percent Pawnee soils, 11 percent Nodaway soils, 11 percent Gymer soils, and 46 percent minor soils (fig. 4).

Pawnee soils are on narrow ridgetops and side slopes in the uplands. They are gently sloping and strongly sloping and are moderately well drained. They formed in glacial till. Typically, the surface layer is very dark gray, friable clay loam or clay about 11 inches thick. The subsoil is about 37 inches thick. The upper part is very dark grayish brown, friable clay loam, and the lower part is dark yellowish brown, mottled, very firm clay. The underlying material to a depth of more than 60 inches is light brownish gray, mottled clay loam.

Nodaway soils are on bottom land. They generally are nearly level but may be very steep on short dropoffs in channeled areas and along streams. They are moderately well drained. They formed in alluvium. Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is very dark grayish brown and grayish brown in the upper part and very dark gray and grayish brown in the lower part.

Gymer soils are on side slopes in the uplands. They are strongly sloping and are well drained. They formed in loess. Typically, the surface layer is dark brown, firm silty clay loam about 6 inches thick. The subsoil is about 34 inches thick. It is brown, very firm silty clay in the upper part and strong brown, friable silty clay loam in the lower part. The underlying material to a depth of more than 60 inches is reddish brown silty clay loam.

Minor in this association are Morrill, Wymore, Mayberry, and Judson soils. Judson soils are on foot slopes. They formed in colluvium and are thicker and darker than the major soils. Morrill soils are on side slopes slightly below the Pawnee soils. They formed in reddish till that is sandier than the parent material of the Pawnee soils. They have less clay than the Gymer soils and are lower on the landscape. Wymore soils formed in

loess. They are on side slopes and are slightly higher on the landscape than the Pawnee and Gymer soils. Mayberry soils are in the same positions on the landscape as the Pawnee soils. Their parent material is more reddish than that of the Pawnee soils.

Farms in areas of this association are diversified. They generally produce cash grain, forage, and livestock. The more nearly level soils are cultivated. Stony areas and areas where the soils are steeper and eroded or inaccessible to modern farm machinery are pastured. In most areas the supply of well water is limited, but the water is generally adequate for domestic use. Water is supplied to some farms through rural water district pipelines. Farm ponds and streams are a source of water for livestock.

Erosion and flooding are the principal hazards if the major soils are cultivated. Stoniness in some areas of the till soils and the droughtiness caused by insufficient

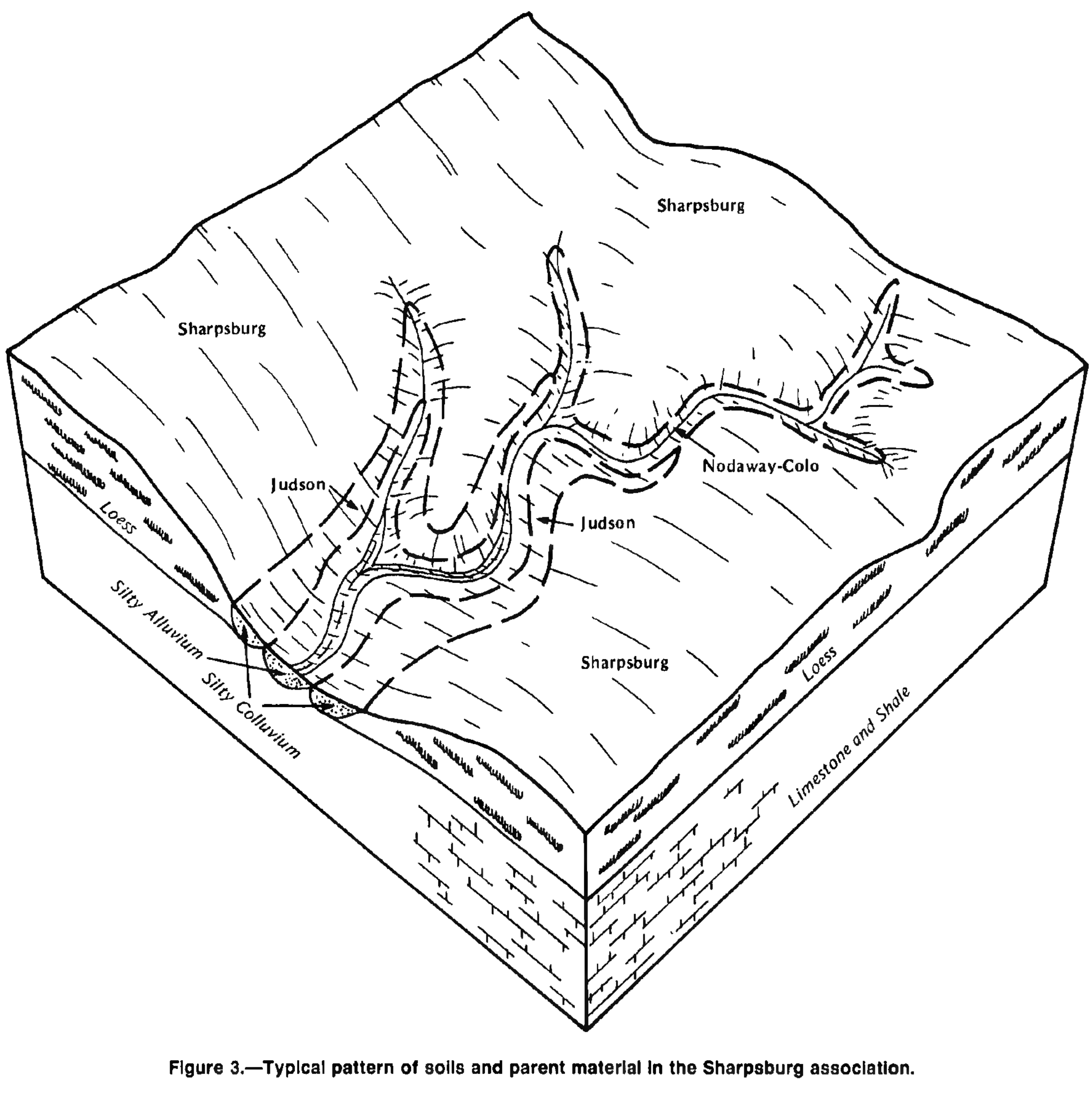

Figure 3.—Typical pattern of soils and parent material in the Sharpsburg association.

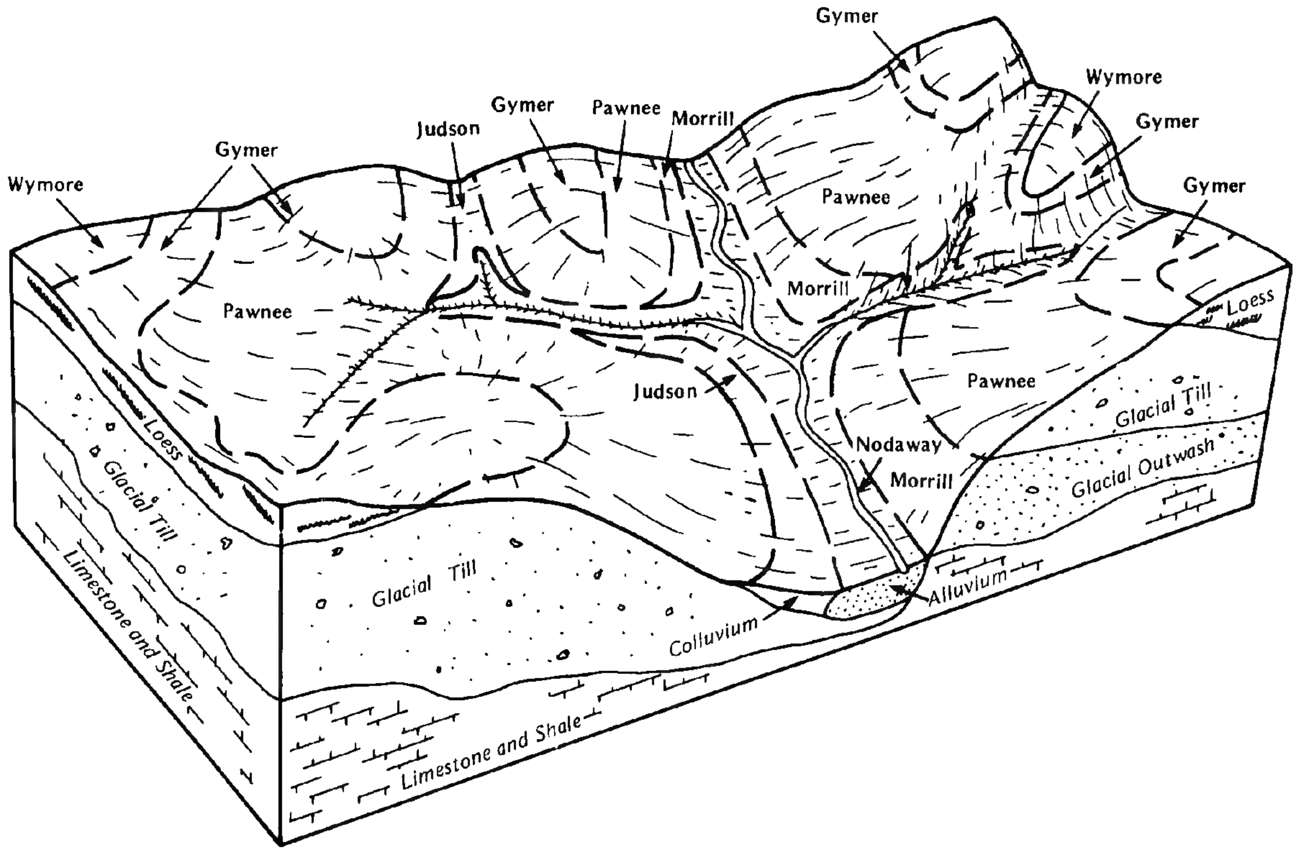

Figure 4.—Typical pattern of soils and parent material in the Pawnee-Nodaway-Gymer association.

rainfall are limitations. Measures that maintain fertility and good tilth and that conserve moisture during dry periods are needed. Erosion can be controlled by contour farming, terraces, grassed waterways, and a conservation tillage system that leaves all or part of the crop residue on the surface. Applications of fertilizer may be needed to maintain fertility. In areas used for pasture, measures that maintain the vigor and growth of the plant community and control brush invasion are the main management needs. Brush can be controlled by timely mechanical and chemical means. Forage production can be increased by rotation grazing.

5. Marshall Association

Deep, gently sloping and strongly sloping, well drained, silty soils formed in loess; on uplands

This association consists of soils on divides, ridgetops, and side slopes along intermittent drainageways. Slopes range from 2 to 11 percent.

This association occupies about 34,505 acres, or 13 percent of the county. It is about 68 percent Marshall soils and 32 percent minor soils.

Typically, the surface layer of the Marshall soils is very dark brown, friable silt loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 4 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is dark brown in the upper part, dark yellowish brown in the next part, and brown in the lower part. The underlying material to a depth of more than 60 inches is brown silt loam. In some areas the surface layer is thinner and lighter colored.

Minor in this association are Sharpsburg, Judson, Monona, Ida, and Nodaway soils. Sharpsburg soils are on side slopes and ridgetops in positions identical to those of the Marshall soils. Their subsoil is more clayey than that of the Marshall soils. Judson soils are on foot slopes, on stream terraces, and in areas adjacent to intermittent drainageways. They are dark to a depth of more than 24 inches. Monona soils are in the slightly steeper areas on ridgetops and on side slopes. They are more silty than the Marshall soils and have more calcium carbonate in the subsoil. Ida soils are in the most convex eroded areas of the association. They are calcareous and are less clayey than the Marshall soils. Nodaway soils are nearly level and are along intermittent

drainageways and on bottom land along streams that dissect the association. They are more silty and more stratified than the Marshall soils.

Farms in areas of this association are diversified. They are mainly a combination of cash-grain and livestock enterprises. Most areas are cultivated. Some areas along intermittent drainageways and streams support native grasses and pasture plants. A few areas are used as permanent pastures. The main dryland crops are corn, soybeans, grain sorghum, wheat, and alfalfa. Livestock winter on crop residue and forage crops. The supply of well water may be limited but generally is adequate for household use. In some areas water is supplied by rural water districts. A few farm ponds and streams furnish water for livestock.

Erosion is the main hazard in cultivated areas. It can be controlled by terraces, contour farming, grassed waterways, and a conservation tillage system that maintains a significant amount of crop residue on the surface. These measures also conserve moisture and improve tilth. In intensively cropped areas, applications of fertilizer may be beneficial. In areas managed for pasture, brush invasion, overgrazing, and erosion are the main management concerns. Proper stocking rates help to keep the pasture in good condition and help to control erosion. Timely mechanical and chemical measures help to control brush.

6. Monona-Ida Association

Deep, gently sloping to very steep, well drained, silty soils formed in loess; on uplands

This association consists of soils on ridges, side slopes, and breaks. Slopes range from 2 to 60 percent.

This association occupies about 28,474 acres, or 11 percent of the county. It is about 49 percent Monona soils, 23 percent Ida soils, and 28 percent minor soils (fig. 5).

Monona soils are on ridges, side slopes along drainageways, and breaks. They are gently sloping to very steep. Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsoil is friable silt loam about 32 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The underlying material to a depth of more than 60 inches is yellowish brown, mottled silt loam.

Ida soils are on long, smooth, convex hillsides, on convex ridges, and on eroded side slopes on the breaks. They are strongly sloping to moderately steep on the hills and steep to very steep on the breaks. Typically, the surface layer is brown, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is brown, calcareous silt loam.

Minor in this association are Marshall, Judson, Kipson, and Nodaway soils. Marshall soils are on ridgetops and the less sloping side slopes. They are more clayey than the Monona soils. Judson soils are on foot slopes and in gently sloping areas along drainageways. Their surface soil is more than 24 inches thick and is darker than that of the major soils. Kipson soils are moderately steep to very steep and are on breaks. They are shallow to bedded shale. Nodaway soils are nearly level and are on bottom land or in channeled areas. They are subject to flooding.

Farms in areas of this association are diversified. They are mainly a combination of cash-grain and livestock enterprises. The gently sloping to moderately steep soils in the smoother areas generally are used for cultivated crops, mainly corn, grain sorghum, wheat, and soybeans. The steeper areas along the breaks generally are used for pasture, range, or woodland. Cattle winter on crop residue. The steepest areas generally are used for pasture, wildlife habitat, or timber.

Erosion is the main hazard if the major soils are cultivated. It can be controlled by contour farming, terraces, grassed waterways, and a conservation tillage system that leaves all or part of the crop residue on the surface. In the steeper areas that are used for pasture or range, overgrazing and brush control are the main management concerns. A planned grazing system and brush control improve the pasture or range and increase forage production.

The supply of well water is limited in some areas, but generally is adequate for household use. Farm ponds are a source of water for livestock. The steep areas along breaks are scenic and have good potential for recreation uses and wildlife habitat. Indian Cave State Park is on the breaks in an area of this association in the southeast corner of the county.

7. Onawa-Haynie-Albaton Association

Deep, nearly level, somewhat poorly drained, moderately well drained, and poorly drained, clayey and silty soils formed in alluvium; on bottom land

This association consists of soils on bottom land 1/2 mile to more than 3 miles wide along the Missouri River. The soils generally are subject to flooding. Water accumulates in the lowest areas. Some areas are slightly undulating. Slopes range from 0 to 2 percent.

This association occupies about 22,019 acres, or 8 percent of the county. It is about 25 percent Onawa soils, 23 percent Haynie soils, 20 percent Albaton soils, and 32 percent minor soils (fig. 5).

Onawa soils generally are higher on the landscape than the Albaton soils and lower than the Haynie soils. They are somewhat poorly drained. Typically, the surface layer is very dark grayish brown, calcareous, firm silty clay or silt loam about 8 inches thick. The upper part of the underlying material is olive gray, mottled, calcareous silty clay. The next part is stratified grayish brown and dark grayish brown, mottled, calcareous silt loam and very fine sandy loam. The lower part to a depth of more

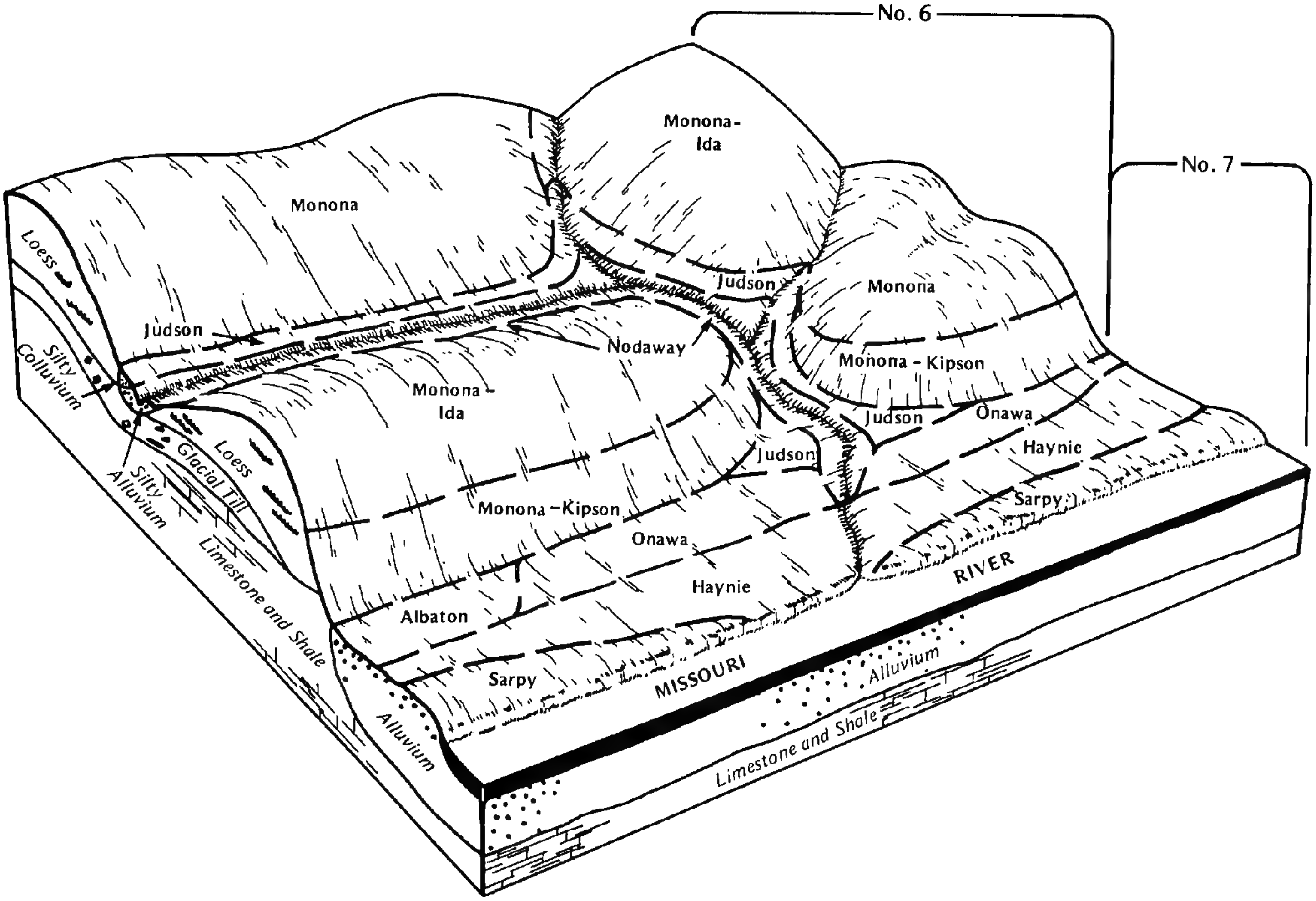

Figure 5.—Typical pattern of soils and parent material in the Monona-Ida and Onawa-Haynie-Albaton associations.

than 60 inches is dark grayish brown, calcareous fine sand.

Haynie soils are in some of the higher landscape positions. They are moderately well drained. Typically, the surface layer is very dark grayish brown, calcareous, friable silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is mottled. It is dark grayish brown, calcareous very fine sandy loam in the upper part and grayish brown silt loam in the lower part.

Albaton soils are in the lower landscape positions. They are poorly drained. Typically, the surface layer is very dark gray, firm silty clay about 8 inches thick. The underlying material to a depth of more than 60 inches is mottled, calcareous silty clay. It is very dark grayish brown in the upper part, very dark gray in the next part, and dark gray in the lower part.

Minor in this association are Nodaway, Blencoe, and Sarpy soils. Nodaway soils are nearer to the areas of upland breaks where streams empty into the valley of the Missouri River than the Haynie soils and may be slightly higher on the landscape. Also, they are less calcareous. Blencoe soils are slightly higher on the landscape than the Onawa and Albaton soils. Also, their surface soil is darker. Sarpy soils are mainly in the higher areas. They are sandy throughout.

Farms in areas of this association are mainly used for row crops. A few areas are used for wheat. Some of the wetter and more sandy areas support native vegetation. These areas have good potential for wildlife habitat and for the production of a limited amount of cottonwood timber. In a few areas the sandier, better drained soils are irrigated and planted to row crops. An abundant supply of well water is available in these areas. Livestock winter on crop residue.

Flooding, wetness, and soil blowing are the main management concerns in cultivated areas. Flood damage can be minimized by diking and by improving drainage. The wetness can be reduced by leveling low areas that are subject to ponding and by improving the drainage system. Soil blowing can be controlled by a conservation tillage system that leaves all or part of the crop residue on the surface and by applications of irrigation water at critical times.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Marshall silty clay loam, 2 to 5 percent slopes, is one of several phases in the Marshall series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Nodaway-Colo silt loams, 0 to 2 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some soil boundaries and soil names in this survey do not fully match those in the surveys of adjoining counties that were published at an earlier date. Differences are the result of changes and refinements in series concepts, different slope groupings, and the application of the latest soil classification system.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

Aa—Ackmore silt loam, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom land. It is occasionally flooded. It formed in alluvium. Areas range from 10 to 150 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The underlying material is about 18 inches of dark grayish brown and very dark gray, stratified silt loam and silty clay loam. It is underlain by a buried horizon of black, friable silty clay loam about 19 inches thick. Below this to a depth of 60 inches or more is dark grayish brown, mottled, silty clay loam.

Included with this soil in mapping are small areas of Nodaway and Zook soils. Nodaway soils are moderately well drained and are in areas adjacent to the drainageways that cross this unit. Zook soils contain more clay than the Ackmore soil. They are in the lower areas. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderate in the Ackmore soil. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is moderately low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is fair.

Most of the acreage is cropland. If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, and grasses. Row crops, including corn and soybeans, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. The major hazard is the occasional flooding following heavy rains. The flooding is of short duration, however, and crop damage is seldom severe. The wetness is the principal limitation, especially during the spring and during periods of high rainfall. It can delay cultivation, planting, and harvesting. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Where feasible, drainage tile can be used to intercept subsurface water. Tilling when the soil is wet can cause excessive compaction, which restricts permeability. Returning crop residue to the soil helps to maintain the content of organic matter and soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, alfalfa, and soybeans. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface conserve moisture. Land leveling improves surface drainage and increases the efficiency of irrigation systems. Irrigation water should be applied in a timely and efficient manner. A tailwater recovery system conserves water.

This soil is a good site for the trees and shrubs grown as windbreaks. The flooding is a hazard, and the wetness is a limitation. Establishing seedlings is sometimes difficult during wet years. Timely cultivation and weed control are management concerns. Tillage and planting should be deferred until after the soil has begun to dry. Weeds can be controlled by cultivating between the rows with conventional equipment. Areas near the trees can be hoed by hand, rototilled, or carefully sprayed with appropriate herbicides.

This soil is not suitable as a site for septic tank absorption fields or buildings because of the flooding and the wetness. A suitable alternative site is needed. Sewage lagoons should be constructed on fill material that raises the bottom of the lagoons to a sufficient height above the seasonal high water table. Also, they should be diked, so that they are protected from flooding.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIw-3, dryland and irrigated; windbreak suitability group 2S.

Ab—Albaton silty clay, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is on broad bottom land. It is occasionally flooded. It formed in clayey alluvium. In many areas shallow surface drainage systems have been installed. Areas range from 20 to several hundred acres in size.

Typically, the surface layer is very dark gray, firm silty clay about 8 inches thick. The underlying material to a depth of more than 60 inches is mottled, calcareous silty clay. It is very dark grayish brown in the upper part, very dark gray in the next part, and dark gray in the lower part.

Included with this soil in mapping are small, intermittent ponds or marshy areas on the slightly lower parts of the landscape. Also included are small areas of the somewhat poorly drained Onawa soils on slightly higher parts of the landscape. These soils contain less clay in the lower part of the underlying material than the Albaton soil. Included areas make up less than 10 percent of the unit.

Permeability is very slow in the Albaton soil. Available water capacity is moderate. Runoff is slow. The depth to the seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is poor, and the soil can be worked only within a narrow range in moisture content. Working the soil is difficult because it is sticky and tough when wet and cracks open and becomes very hard when it dries.

Most of the acreage is cropland. Some areas are used for pasture or support native trees.

If used for dryland farming, this soil is suited to soybeans, corn, grain sorghum, and wheat. The wetness is the principal limitation. Grain sorghum and soybeans are better suited than corn because they can be planted later in the spring. Also, corn is adversely affected by hot, dry periods in the summer, when the plants are in a critical stage of development. The soil holds moisture tightly and does not release it fast enough to maintain the corn plants. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Filling low areas and establishing a general land grade also help to drain surface water. In places surface ditching is feasible. Excessive compaction and unnecessary tillage should be avoided. Tilling when the soil is wet can cause excessive compaction, which further restricts permeability. Returning crop residue to the soil increases the content of organic matter and

improves soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, and alfalfa. It also can be used for small grain and grasses. The rate of water application should correspond with the very low water intake rate of the soil. Land leveling, which results in smooth, level fields, and constructing dikes, which divert floodwater, help to prevent ponding. A furrow or border irrigation system is suitable.

This soil is suited to introduced grasses for pasture, such as a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. Excessive wetness limits the choice of suitable pasture grasses and legumes. Grazing when the water table is highest results in damage to the grass stand, a rough soil surface, and difficulty in mowing for hay. Because of the wetness, seeding the grasses can be difficult. A drainage system of V-ditches or perforated tile reduces the wetness. Proper grazing use, proper stocking rates, and rotation grazing help to keep the pasture in good condition. Applying nitrogen fertilizer increases forage production.

This soil generally is a good site for trees and shrubs grown as windbreaks or as plantings that enhance recreation areas or wildlife habitat. The survival rate of adapted species is good. The main limitation is the excessive wetness. Establishing seedlings is difficult in wet years. Timely cultivation and weed control are management concerns. Weeds can be controlled by cultivating with conventional equipment before and after planting and by applying carefully selected herbicides. In some years cultivating and planting should be postponed because the soil is too wet.

Some areas of this soil, especially those adjacent to or near the Missouri River, support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suited to septic tank absorption fields because of the flooding, the wetness, and the very slow permeability. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding. Also, they should be constructed on fill material that raises the bottom of the lagoons to a sufficient height above the seasonal high water table.

This soil is not suitable as a site for buildings because of the flooding, the wetness, and the high shrink-swell potential. Local roads and streets should be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Providing coarser grained subgrade or base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability unit is IIIw-1, dryland and irrigated; windbreak suitability group 2W.

BfD2—Benfield-Kipson silty clay loams, 6 to 11 percent slopes, eroded. These strongly sloping soils are on upland side slopes bordering intermittent drainageways. The moderately deep, well drained Benfield soil formed in clayey shale residuum, generally on the lower concave slopes. The shallow and very shallow, somewhat excessively drained Kipson soil formed in shaly residuum on convex slopes above the Benfield soil. Erosion has removed most of the original surface layer. The rest is being mixed with the subsoil by tillage. Areas generally are dissected by shallow drainageways and are long and narrow. They range from 10 to 100 acres in size. They are about 50 to 70 percent Benfield soil and 30 to 50 percent Kipson soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Benfield soil has a very dark grayish brown, friable silty clay loam surface layer about 8 inches thick. The subsoil is dark brown, friable silty clay loam about 12 inches thick. The underlying material is grayish brown, calcareous silty clay loam. Light brownish gray bedded shale is at a depth of about 26 inches. In some areas the subsoil is highly calcareous. In other areas the bedrock is below a depth of 40 inches.

Typically, the Kipson soil has a very dark grayish brown, friable, calcareous silty clay loam surface layer about 7 inches thick. The underlying material is light brownish gray, friable, calcareous shaly silty clay loam. Mixed light yellowish brown and dark grayish brown bedded shale is at a depth of about 15 inches.

Included with these soils in mapping are small areas of the Sharpsburg and Wymore soils, which formed in loess. The included soils are in positions on the landscape similar to those of the Benfield and Kipson soils. Also included are small areas of the very shallow Sogn soils on slightly higher parts of the landscape. Included soils make up less than 5 percent of the unit.

Permeability is slow in the Benfield soil and moderate in the Kipson soil. Available water capacity is moderate in the Benfield soil and low in the Kipson soil. Runoff is rapid on both soils. Organic matter content is moderate. The shrink-swell potential is high in the Benfield soil and moderate in the Kipson soil. Tilth is fair in both soils.

Most of the acreage is cropland. Some small areas are used for pasture or range.

If used for dryland farming, these soils are poorly suited to drought-resistant, close-growing crops, such as grain sorghum, wheat, and introduced grasses and legumes. Corn and soybeans can be grown in rotation with these crops in years of favorable moisture. Furthur erosion is a hazard. It can be controlled by grassed waterways, contour farming, and terraces. Conservation

tillage practices, such as chiseling and no-till planting, that return crop residue to the soil help to control erosion, conserve moisture, and add organic matter. Applications of organic fertilizer improve fertility.

These soils are suited to introduced grasses and legumes for pasture. Cool-season grasses, such as smooth brome and orchardgrass, are suited, either alone or in a mixture with legumes. Erosion is a hazard. If the pasture is overgrazed, plant vigor is poor and small gullies and rills can form after heavy rains. An adequate plant cover is needed to help control erosion. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applications of nitrogen fertilizer increase forage production.

These soils are suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, sideoats grama, and switchgrass. When the plants are continuously overgrazed, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, blue grama, tall dropseed, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable woody plants, including bur oak, sumac, buckbrush, and dogwood, increase in abundance.

These soils are poor sites for the trees and shrubs grown as farmstead or feedlot windbreaks or as plantings that enhance recreation areas or wildlife habitat. The Benfield soil is poorly suited to field windbreaks, and the Kipson soil is generally unsuited. The survival and growth rates of adapted species are poor. The main hazards or limitations affecting tree planting are the high clay content, soil depth, drought, competition from undesirable weeds and grasses, excessive slope, excessive runoff, and the formation of cracks, which results from shrinking and swelling. Because of the content of clay, the trees should be planted when the soils are moist, but not when they are wet. Supplemental watering can overcome droughtiness during periods of insufficient moisture. Cultivation with conventional equipment, annual cover crops between the rows, and applications of appropriate herbicides in the rows help to control the undesirable weeds and grasses. In some areas hand hoeing or rototilling is needed. Planting on the contour conserves moisture and helps to prevent excessive runoff and erosion. Light cultivation helps to eliminate surface cracks and helps to protect the roots.

These soils generally are not suitable as sites for septic tank absorption fields or sewage lagoons, mainly because of the depth to bedrock. A suitable alternative site is needed.

If these soils are used as sites for buildings, the shrink-swell potential is a limitation. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. The soft bedrock underlying the Kipson soil should be excavated if dwellings with basements or buildings that have deep foundations are constructed. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to an acceptable gradient.

Local roads and streets constructed across areas of these soils should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Cutting and filling generally are needed to provide a suitable grade. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling of the Benfield soil. The soft bedrock underlying the Kipson soil should be excavated.

The capability unit is IVe-2, dryland. The Benfield soil is in windbreak suitability group 4L, and the Kipson soil is in windbreak suitability group 10.

BfF—Benfield-Kipson silty clay loams, 11 to 30 percent slopes. These moderately steep and steep soils are on upland side slopes bordering intermittent drainageways. The moderately deep, well drained Benfield soil formed in clayey shale residuum, generally on the lower concave slopes. The shallow and very shallow, somewhat excessively drained Kipson soil formed in shaly residuum on convex slopes above the Benfield soil. Areas generally are long and narrow. They range from 10 to 100 acres in size. They are about 45 to 65 percent Benfield soil and 35 to 55 percent Kipson soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Benfield soil has a very dark gray, friable silty clay loam surface layer about 7 inches thick. The subsoil is firm silty clay loam about 15 inches thick. The upper part is dark grayish brown, and the lower part is light brownish gray. The underlying material is light brownish gray silty clay loam. Light brownish gray bedded shale is at a depth of about 38 inches. In some areas the subsoil is highly calcareous and is light yellowish brown.

Typically, the Kipson soil has a very dark gray, friable, calcareous silty clay loam surface layer about 7 inches thick. The underlying material is grayish brown, friable, calcareous shaly silty clay loam. Light yellowish brown bedded shale is at a depth of about 20 inches.

Included with these soils in mapping are small areas of Sharpsburg and Wymore soils, which formed in loess. These included soils are in positions on the landscape similar to those of the Benfield and Kipson soils. Also included are small areas where shale and limestone crop out and, on the slightly higher parts of the landscape, small areas of the very shallow Sogn soils and soils that are shallow to bedded shale. Included areas make up less than 5 percent of the unit.

Permeability is slow in the Benfield soil and moderate in the Kipson soil. Available water capacity is moderate in the Benfield soil and low in the Kipson soil. Runoff is rapid on both soils. Organic matter content is moderate. The shrink-swell potential is high in the Benfield soil and moderate in the Kipson soil.

Most of the acreage is range. A few areas support scattered native trees. These soils are unsuited to cultivation because of the slope and because of outcrops of shale and limestone.

These soils are suited to range. A cover of range plants is effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, sideoats grama, and switchgrass. When the plants are overgrazed, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, blue grama, tall dropseed, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable woody plants, including bur oak, sumac, buckbrush, and dogwood, increase in abundance.

These soils generally are poor sites for the trees and shrubs grown as windbreaks or as plantings that enhance recreation areas or wildlife habitat. The survival and growth rates of adapted species are poor. In some areas trees and shrubs can be grown only if hand planting, scalp planting, special site preparation, or other special management is applied.

These soils generally are not suitable as sites for sanitary facilities because of the slope and the depth to bedrock. A suitable alternative site is needed. Dwellings should be designed so that they conform to the natural slope of the land. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. The soft bedrock underlying the Kipson soil should be excavated if dwellings with basements or buildings that have deep foundations are constructed.

Local roads and streets constructed across areas of these soils should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarse grained base material helps to ensure better performance. Cutting and filling generally are needed to provide a suitable grade. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling of the Benfield soil. The soft bedrock underlying the Kipson soil should be excavated.

The capability unit is VIe-2, dryland; windbreak suitability group 10.

Bn—Blencoe silty clay, clayey substratum, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad bottom land in the valley of the Missouri River. It is subject to rare flooding. It formed in clayey and silty alluvium. Areas range from 40 to several hundred acres in size.

Typically, the surface layer is black, very firm silty clay about 7 inches thick. The subsurface layer also is black, very firm silty clay. It is about 8 inches thick. The subsoil is dark grayish brown, mottled, very firm silty clay about 7 inches thick. The upper part of the underlying material is grayish brown, mottled, calcareous silt loam. The lower part to a depth of more than 60 inches is dark gray, mottled, calcareous silty clay. In some areas the surface layer is silty clay loam, and in other areas it is lighter colored.

Included with this soil in mapping are small areas of Albaton soils. These soils are finer textured than the Blencoe soil. They are in positions on the landscape similar to those of the Blencoe soil. They make up less than 10 percent of the unit.

Permeability is slow in the upper part of the Blencoe soil, moderate in the next part, and very slow in the lower part. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is poor, and the soil can be worked only within a narrow range in moisture content. Working the soil is difficult because it is sticky and tough when wet and cracks open and becomes very hard when it dries.

Nearly all of the acreage is cropland. If used for dryland farming, this soil is suited to corn, soybeans, alfalfa, and grain sorghum and to introduced grasses for pasture. The poor tilth, the slow permeability, and the high water table are limitations in cultivated areas. Maintaining good tilth and preparing a good seedbed are difficult. Tilling in the fall lessens the need for tillage in the spring, when the soil is wet. In many areas surface ditches remove runoff. Conservation tillage practices that keep crop residue on the surface improve tilth and increase the rate of water intake.

If irrigated, this soil is suited to row crops, such as corn, soybeans, and grain sorghum, and to close-sown crops, such as alfalfa and small grain. The high water table, the very low intake rate, and the poor tilth are the main limitations. Land leveling generally is needed if a gravity irrigation system is used. Tailwater recovery systems can be installed at the lower end of the field to recycle irrigation runoff. Irrigation by sprinklers is suitable, but a slow application rate is needed because of the very low intake rate.

This soil generally is a good site for the trees and shrubs grown as windbreaks. The wetness and the high clay content in the surface layer are the main limitations. The survival rate of adapted species is good. Good site preparation, timely cultivation, and careful, timely applications of appropriate herbicides help to control weeds and grasses. Only the species that can withstand the occasional wetness should be selected for planting.

This soil generally is not suitable as a septic tank absorption field because of the wetness and the slow permeability. A suitable alternative site is needed. Sewage lagoons should be diked so that they are protected from flooding. Also, they should be constructed on fill material that raises the bottom of the lagoon to a sufficient height above the seasonal high water table. Constructing dwellings and small commercial buildings on elevated, well-compacted fill material helps to prevent the damage caused by flooding and helps to overcome the wetness caused by the high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarse grained base material helps to ensure better performance. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability unit is IIw-1, dryland and irrigated; windbreak suitability group 2S.

BrE—Burchard clay loam, 11 to 15 percent slopes. This deep, moderately steep, well drained soil is on side slopes in the loess-capped glacial uplands. It is commonly adjacent to the major drainageways. It formed in glacial till. Areas are long and narrow. They range from 5 to 60 acres in size.

Typically, the surface layer is black, friable clay loam about 8 inches thick. The subsurface layer is very dark gray, friable clay loam about 5 inches thick. The subsoil is firm, clay loam about 29 inches thick. The upper part is dark brown, the next part is brown, and the lower part is mixed light olive brown and light brownish gray. The underlying material to a depth of more than 60 inches is light brownish gray clay loam. In places the surface layer is loam. In the more eroded areas, lime is at or near the surface.

Included with this soil in mapping are small areas of Morrill and Pawnee soils. Morrill soils formed in reddish brown material on the lower slopes. Pawnee soils contain more clay throughout than the Burchard soil. They are on the higher slopes. Also included are escarpments along creek channels and deeply entrenched narrow bottom land and areas where many rocks and boulders are on the surface. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Burchard soil. Available water capacity is high. Runoff is rapid. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

If used for dryland farming, this soil is poorly suited to wheat and grain sorghum. Erosion is a hazard unless the surface is adequately protected. Conservation tillage practices help to prevent excessive soil loss. Smooth slopes can be terraced and farmed on the contour. Returning crop residue to the soil and regularly adding manure improve fertility and help to maintain good tilth.

Most of the acreage is pasture or range. This soil is suited to introduced grasses and legumes for pasture. A cover of these plants is very effective in controlling erosion. Overgrazing or improper haying methods reduce the extent of the protective plant cover and cause deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help keep the pasture in good condition.

This soil is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. When the plants are overgrazed, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance. Range seeding is needed to stabilize some severely eroded areas.

This soil is a good site for the trees and shrubs grown as windbreaks. Native trees and coniferous trees and shrubs can grow well. Erosion is a hazard during periods when the windbreak is being established. Competition for moisture from grasses and weeds is the principal limitation affecting the establishment of seedlings. Planting on the contour and establishing cover crops between the rows help to control erosion. Careful use of appropriate herbicides and cultivation between the trees help to control the competing grasses and weeds. The seedlings should be protected from livestock.

The moderately slow permeability is a limitation if this soil is used as a septic tank absorption field. It generally can be overcome, however, by increasing the size of the absorption field. Land shaping and installing the absorption field on the contour help to ensure proper performance. If the soil is used as a site for sewage lagoons, extensive grading is needed to modify the slope and shape the lagoon. Dwellings and small commercial buildings should be designed so that they conform to the natural slope of the land. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better

performance. Cutting and filling generally are needed to provide a suitable grade.

The capability unit is IVe-1, dryland; windbreak suitability group 3.

Co—Colo silty clay loam, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad bottom land. It is occasionally flooded. It formed in silty alluvium. Areas range from about 15 to 110 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer also is black, friable silty clay loam. It is about 22 inches thick. The next 6 inches is a transitional layer of very dark gray, mottled, friable silty clay loam. The underlying material to a depth of more than 60 inches is dark gray, mottled silty clay loam. In some areas a thin layer of stratified overwash is on the surface.

Included in this soil in mapping are small areas of the moderately well drained Kennebec soils. These soils are in positions on the landscape similar to those of the Colo soil or are in slightly higher positions. Also included are small areas of the clayey Zook soils in the slightly lower positions on the landscape. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderate in the Colo soil. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from about 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is low. Organic matter content is high. The shrink-swell potential also is high. Tilth is fair.

Nearly all of the acreage is cropland. If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, and introduced grasses. Row crops, including corn, and soybeans, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. The occasional flooding is the principal hazard. It is controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. The wetness is the principal limitation, especially during the spring and during periods of high rainfall. It can delay cultivation, planting, and harvesting. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Where feasible, drainage tile can be used to intercept subsurface water. Tilling when the soil is wet can cause excessive compaction, which restricts permeability. Returning crop residue to the soil helps to maintain the content of organic matter and soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, alfalfa, and soybeans. The occasional flooding is the principal hazard. It can be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface conserve moisture. Land leveling improves surface drainage and increases the efficiency of irrigation systems. Irrigation water should be applied in a timely and efficient manner. A tailwater recovery system conserves water.

This soil generally is a good site for the trees and shrubs grown as windbreaks. The wetness is a limitation, and the occasional flooding is a hazard. Establishing seedlings is sometimes difficult during wet years. Timely cultivation and weed control are management concerns. Tillage and planting should be deferred until after the soil has begun to dry. Weeds can be controlled by cultivating between the rows with conventional equipment. Areas near the trees can be hoed by hand, rototilled, or carefully sprayed with appropriate herbicides.

This soil is not suitable as a site for septic tank absorption fields or buildings because of the flooding and the wetness. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding. Also, they should be constructed on fill material that raises the bottom of the lagoon to a sufficient height above the seasonal high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIw-4, dryland, and IIw-3, irrigated; windbreak suitability group 2S.

Gn—Grable very fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, somewhat excessively drained soil is on broad bottom land in the valley of the Missouri River. It is occasionally flooded. It formed in loamy and sandy alluvium. Areas range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, friable very fine sandy loam about 8 inches thick. The upper part of the underlying material is stratified grayish brown and dark grayish brown very fine sandy loam. The lower part to a depth of about 60 inches is dark grayish brown fine sand. In a few areas, the surface layer is loam or fine sandy loam.

Included with this soil in mapping are small areas of the silty Haynie soils in the slightly lower landscape

positions and the sandy Sarpy soils in the higher positions. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Grable soil and rapid in the lower part. Available water capacity is moderate. Runoff is slow. The water intake rate for irrigation is moderate. Organic matter content is low. The soil may be deficient in nitrogen and phosphorus. Tilth is good.

Most of the acreage is cropland. A few areas are used for pasture or support native trees.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, small grain, and alfalfa. The occasional flooding is the principal hazard. It can be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. Conservation of water and control of soil blowing are important concerns of management. Row crops can be grown in consecutive years if the proper amounts and kinds of fertilizer are applied and if weeds and insects are controlled. Conservation tillage practices conserve moisture and help to control soil blowing. Selecting cool-season small grain and drought-resistant crops for planting minimizes the low moisture supply.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, alfalfa, and small grain. The occasional flooding is the principal hazard. It can be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. Row crops can be grown in consecutive years if the proper amounts and kinds of fertilizer are applied and if weeds and insects are controlled. If gravity irrigation systems are used, land leveling generally is needed to increase the efficiency of water distribution. Sprinkler systems also are suited. They can distribute water efficiently. Conservation tillage practices, such as disking and chiseling, that leave most of the crop residue on the surface conserve moisture and help to control soil blowing.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or improper haying methods, however, reduce the extent of the protective plant cover and cause deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil generally is a good site for the trees and shrubs grown as windbreaks. The survival rate of adapted species is good. Competition for moisture from grasses and weeds is a concern of management. Cultivation between the rows and proper use of appropriate herbicides or hand hoeing in the rows help to control the weeds and grasses. Supplemental watering may be beneficial during periods when rainfall is insufficient.

Some areas of this soil, especially those adjacent to or near the Missouri River, support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suitable as a site for buildings or septic tank absorption fields because of the flooding. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding. Lining or sealing the lagoons helps to prevent seepage. Shoring shallow excavations helps to prevent cave-in of the sandy material. Constructing local roads and streets on suitable, well compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding.

The capability units are IIs-5, dryland, and I-6, irrigated; windbreak suitability group 1.

GyD2—Gymer silty clay loam, 5 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on uplands that generally are dissected by shallow drainageways and rills. The soil formed in reddish brown loess. Erosion has removed most of the original surface layer. The rest is being mixed with the subsoil by tillage. Areas are long and narrow and range from 5 to 40 acres in size.

Typically, the surface layer is dark brown, firm silty clay loam about 6 inches thick. The subsoil is about 34 inches thick. It is brown, very firm silty clay in the upper part and is strong brown, friable silty clay loam in the lower part. The underlying material to a depth of more than 60 inches is reddish brown silty clay loam.

Included with this soil in mapping are small areas of Mayberry and Morrill soils on the lower parts of side slopes. These soils formed in glacial material. Morrill soils contain less clay in the subsoil than the Gymer soil. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderately slow in the Gymer soil. Available water capacity is high. Runoff is medium. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is fair.

Most of the acreage is cropland. A few small areas are used for pasture.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, and grasses and legumes. Further erosion is the main hazard, and conservation of water is an important management concern. Conservation tillage practices, such as till-plant and no-till planting, that leave crop residue on the surface help to control erosion and conserve moisture. Terraces conserve surface water and help to control erosion. Contour farming and grassed waterways also help to control erosion. Measures that improve fertility are needed on this eroded soil. Examples are applying

commercial fertilizer and including legumes in the cropping sequence.

This soil is suited to introduced grasses for pasture, such as a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. Erosion is a hazard. If the pasture is overgrazed, plant vigor is poor and small gullies and rills can form after heavy rains. Proper stocking rates and rotation grazing help to keep the pasture in good condition.

This soil is a poor site for the trees and shrubs grown as farmstead or feedlot windbreaks or as plantings that enhance recreation areas or wildlife habitat. It is poorly suited to field windbreaks. The survival and growth rates of adapted species are fair or poor. The main hazards or limitations affecting tree planting are the high clay content, drought, competition from undesirable weeds and grasses, excessive slope, excessive runoff, and the formation of cracks, which results from shrinking and swelling. Because of the content of clay, the trees should be planted when the soil is moist, but not when it is wet. Supplemental watering can overcome droughtiness during periods of insufficient moisture. Cultivation with conventional equipment, annual cover crops between the rows, and applications of appropriate herbicides in the rows help to control the undesirable weeds and grasses. In some areas hand hoeing or rototilling is needed. Planting on the contour conserves moisture and helps to prevent excessive runoff and erosion. Light cultivation helps to eliminate surface cracks and helps to protect the roots.

The moderately slow permeability is a limitation if this soil is used as a septic tank absorption field. This limitation generally can be overcome, however, by increasing the size of the absorption field. If the soil is used as a site for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. The buildings should be designed so that they conform to the natural slope of the land; or the site should be graded to an acceptable gradient.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

The capability unit is IVe-8, dryland; windbreak suitability group 4L.

Hb—Haynie silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on bottom land in the valley of the Missouri River. It is occasionally flooded. It formed in alluvium. Areas range from 40 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, calcareous, friable silt loam about 8 inches thick. The upper part of the underlying material is dark grayish brown, mottled, calcareous very fine sandy loam. The lower part to a depth of about 60 inches is grayish brown, mottled silt loam. In some areas the surface layer is very fine sandy loam.

Included with this soil in mapping are small areas of Onawa and Sarpy soils. Onawa soils are clayey in the upper part. They are in the lower areas. Sarpy soils are sandy throughout. They are in the slightly higher areas. Included soils make up 2 to 10 percent of the unit.

Permeability is moderate in the Haynie soil. Available water capacity is high. Runoff is slow. The water intake rate for irrigation is moderate. Organic matter content is moderate. The soil may be deficient in nitrogen. Tilth is good. The soil dries quickly after rains and can be worked throughout a wide range in moisture content.

Most of the acreage is cropland. The areas closer to the river commonly support native trees. Timber logs are harvested in some of these areas. Otherwise, the areas provide excellent wildlife habitat.

If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, forage sorghum, and grasses. The occasional flooding and soil blowing are the principal hazards. Row crops, such as corn, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. Flooding is controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. Conservation tillage practices that leave crop residue on the surface help to maintain the rate of water intake and the content of organic matter, conserve moisture, and reduce the susceptibility to soil blowing. Applications of fertilizer improve or maintain fertility.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, alfalfa, and small grain. The occasional flooding and soil blowing are the principal hazards. Flooding is controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. Row crops can be grown in consecutive years if the proper amounts and kinds of fertilizer are applied and if weeds and insects are controlled. If gravity irrigation systems are used, land leveling generally is needed to increase the efficiency of water distribution. Sprinkler systems also are suited. They can distribute water efficiently. Conservation tillage practices conserve moisture and help to control soil blowing.

This soil generally is a good site for the trees and shrubs grown as windbreaks. Competition from weeds and grasses and a high content of calcium carbonate are the main limitations. Seedlings generally survive and grow well if moisture is conserved and the competing plants are controlled or removed. The weeds and grasses can be controlled by cultivating with conventional equipment between the rows and by hand hoeing, rototilling, and carefully applying appropriate

herbicides in the rows. Annual cover crops can be grown between the rows. The species selected for planting should be those that can withstand the excessive amount of calcium carbonate in the soil.

Some areas of this soil, especially those adjacent to or near the Missouri River, support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suitable as a site for buildings or septic tank absorption fields because of the flooding. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding. Lining or sealing the lagoons helps to prevent seepage.

Constructing local roads and streets on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. The roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIw-3, dryland and irrigated; windbreak suitability group 1L.

Hd—Haynie silty clay, overwash, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on bottom land in the valley of the Missouri River. It is occasionally flooded. It formed in alluvium. Areas range from 10 to 120 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay about 7 inches thick. The upper part of the underlying material is mixed dark grayish brown and brown, mottled silty clay. The next part is stratified dark grayish brown and grayish brown, mottled, calcareous silt loam and very fine sandy loam. The lower part to a depth of about 60 inches is brown, mottled loamy very fine sand. In some areas the upper layer of silty clay is thinner. In other areas thin strata of silty clay are in the underlying material.

Included with this soil in mapping are small areas of Onawa and Sarpy soils. Onawa soils are somewhat poorly drained and are in the slightly lower areas. Sarpy soils are sandy throughout. They are on long, narrow ridges. Included soils make up 2 to 10 percent of the unit.

Permeability is slow in the upper part of the Haynie soil and moderate in the lower part. Available water capacity is high. Runoff is slow. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high in the surface layer and the upper part of the underlying material. Tilth is poor, and the soil can be worked only within a narrow range in moisture content. Working the soil is difficult because it is sticky and tough when wet and cracks open and becomes very hard when it dries.

Nearly all of the acreage is cropland. If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, forage sorghum, and grasses. Row crops, such as corn, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. The occasional flooding is the principal hazard. It can be controlled by diversions and dikes on the local flood plain. Conservation tillage practices that leave crop residue on the surface help to maintain the rate of water intake and the content of organic matter, conserve moisture, and help to control soil blowing. Applications of fertilizer improve or maintain fertility.

If irrigated, this soil is suited to corn, soybeans, grain sorghum, alfalfa, and small grain. The very low rate of water intake is the major limitation in irrigated areas. Row crops can be grown in consecutive years if the proper amounts and kinds of fertilizer are applied and if weeds and insects are controlled. If gravity irrigation systems are used, land leveling generally is needed to increase the efficiency of water distribution. Sprinkler systems also are suited. They can distribute water efficiently. Conservation tillage practices conserve moisture and help to control soil blowing.

This soil generally is a good site for the trees and shrubs grown as windbreaks. The survival rate of adapted species is good. Seedlings generally survive and grow well if moisture is conserved and competing vegetation is controlled or removed. The competing weeds and grasses can be controlled by cultivating with conventional equipment between the rows and by hand hoeing, rototilling, and carefully applying appropriate herbicides in the rows. The species selected for planting should be those that can withstand the excessive amount of calcium carbonate in the soil.

Some areas of this soil, especially those adjacent to or near the Missouri River, support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suitable as a site for buildings or septic tank absorption fields because of the flooding. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding. Lining or sealing the lagoons helps to prevent seepage.

Constructing local roads and streets on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. The roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. A good surface drainage system helps to prevent the

damage caused by frost action. Crowning the road by grading helps provide the needed surface drainage.

The capability unit is IIw-1, dryland and irrigated; windbreak suitability group 1L.

Ju—Judson silt loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on stream terraces and foot slopes. It formed in silty sediments. Areas are 5 to 30 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 8 inches thick. The subsurface layer is about 18 inches thick. It is very dark gray, friable silt loam in the upper part and dark brown, friable silty clay loam in the lower part. The subsoil is friable silty clay loam about 24 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The underlying material to a depth of more than 60 inches is yellowish brown silty clay loam. In a few areas the surface layer is lighter colored overwash. In some places the subsoil is lighter colored, and in other places it is slightly more clayey.

Included with this soil in mapping are small areas of Colo and Nodaway soils on bottom land. Colo soils are somewhat poorly drained, and Nodaway soils are moderately well drained. Included soils make up 2 to 5 percent of the unit.

Permeability is moderate in the Judson soil. Available water capacity is high. Runoff is slow. The water intake rate for irrigation is moderately low. Organic matter content is high. The shrink-swell potential is moderate. The soil dries readily after rains and can be worked throughout a fairly wide range in moisture content.

Most of the acreage is cultivated. If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface conserve moisture. Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. The amount of available soil moisture helps to determine the proper plant population. Returning crop residue to the soil increases the rate of water intake and helps to maintain the organic matter content. Timely tillage is needed. Working the soil when it is too wet can cause compaction.

If irrigated, this soil is suited to corn, alfalfa, and soybeans. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface conserve moisture. Land leveling improves surface drainage and increases the efficiency of irrigation systems. The water should be applied in a timely and efficient manner. A tailwater recovery system conserves water.

This soil generally is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas. The survival rate of adapted species is good. Competition from weeds and grasses is the main limitation. It can be controlled by cultivating with conventional equipment between the rows and by hand hoeing, rototilling, and applying appropriate herbicides in the rows.

This soil generally is suitable as a septic tank absorption field. Seepage is a problem if the soil is used as a site for sewage lagoons. It can be controlled by lining or sealing the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. A good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are I-1, dryland, and I-4, irrigated; windbreak suitability group 1.

JuC—Judson silt loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on foot slopes along narrow upland drainageways and on stream terraces. It formed in silty sediments. Areas are long and narrow and are 5 to 40 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 8 inches thick (fig. 6). The subsurface layer is about 18 inches thick. It is very dark brown, friable silt loam in the upper part and very dark grayish brown, friable silty clay loam in the lower part. The subsoil to a depth of more than 60 inches is dark brown, friable silty clay loam. In some areas the surface layer is loam. In other areas, the subsoil is more strongly expressed and the surface layer is thinner.

Included with this soil in mapping are small areas of Colo and Zook soils on bottom land. Colo soils are somewhat poorly drained. Zook soils are poorly drained. Included soils make up 2 to 10 percent of the unit.

Permeability is moderate. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is moderately low. Organic matter content is high. The shrink-swell potential is moderate. Tilth is good.

Most of the acreage is cultivated. Small tracts support grasses and are used mainly for pasture.

If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Erosion is the principal hazard if row crops are grown. It can be controlled by minimizing tillage, returning crop residue to the soil, and farming on the contour. Terraces and diversions can be used in some areas to protect the soil from the concentrated runoff from the adjacent upland slopes. Row crops, such as

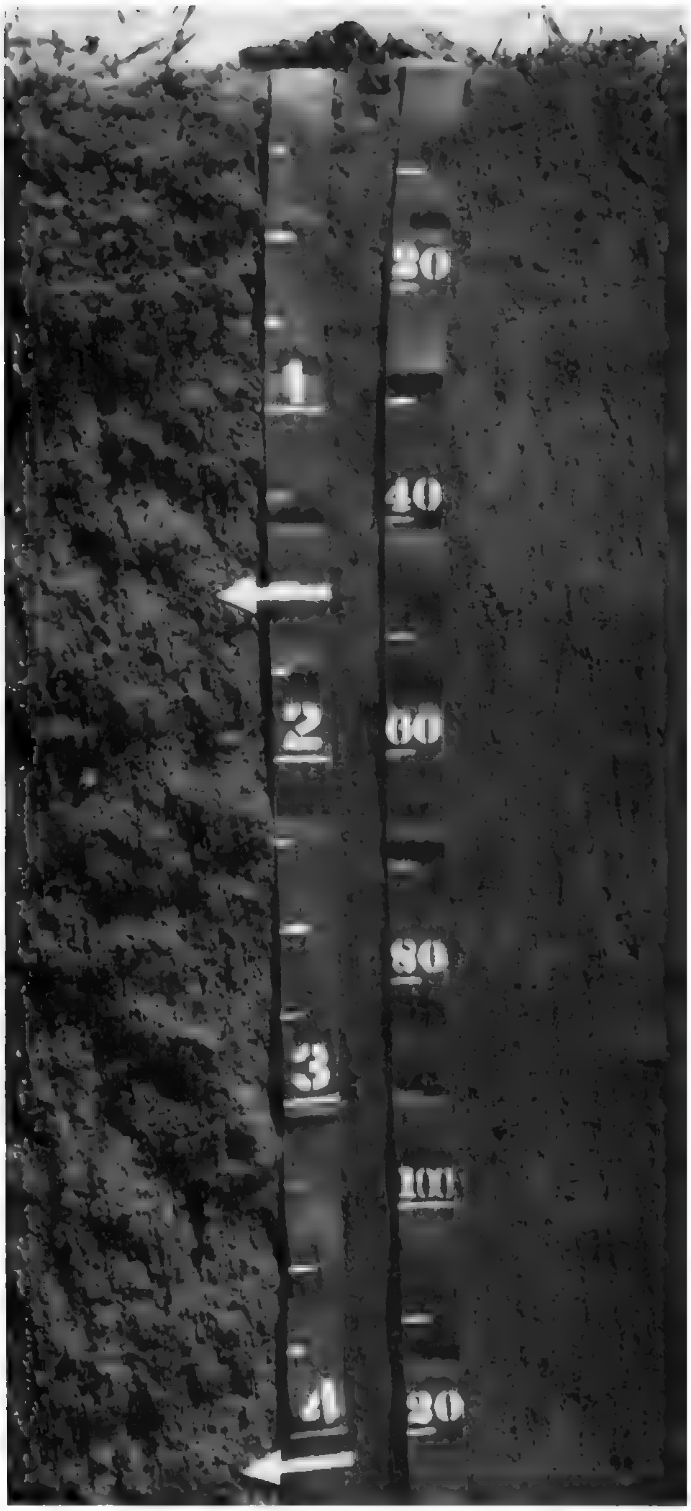

Figure 6.—Profile of Judson silt loam, 2 to 6 percent slopes. This soil is dark colored. The upper arrow identifies the subsurface layer and the lower arrow the subsoil. The scale on the left is marked in feet, and the scale on the right is marked in centimeters.

corn and soybeans, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. The amount of available soil moisture helps to determine the proper plant population. Timely tillage is needed. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility.

This soil is suited to sprinkler irrigation. Measures that control erosion are needed. If a gravity irrigation system is used, the soil should be bench leveled or the crops should be grown on the contour. Conservation tillage practices are especially desirable because they help to keep crop residue on the surface.

This soil is suited to introduced grasses and legumes for pasture. If introduced grasses, such as smooth brome, are grown, applications of fertilizer and a grazing system that includes rotation grazing and deferred grazing are needed. Resting the pasture allows the plants to store food reserves in their roots and rhizomes and helps to control erosion by maintaining a protective plant cover. Sufficient leaf growth is needed if the plants are to remain healthy and are to store food reserves for growth during the next season. Separate pastures of cool-season and warm-season grasses can be used to provide a long grazing season.

This soil is a good site for the trees and shrubs grown as windbreaks. Competition from weeds and grasses and erosion are the main management concerns. Seedlings generally survive and grow well if moisture is conserved and if the competing vegetation is controlled or removed. Cultivating between the rows with conventional equipment conserves moisture and helps to control the competing weeds and grasses. Hand hoeing, rototilling, and applying appropriate herbicides help to control the weeds in the rows. Planting on the contour helps to control erosion.

This soil generally is suitable as a septic tank absorption field. Seepage is a problem if the soil is used as a site for sewage lagoons. It can be controlled by lining or sealing the lagoon. Grading is needed to modify the slope and shape the lagoon. The shape of the lagoon should conform to the natural slope of the land. Strengthening the foundations and footings of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Terraces and diversions can be used in some areas to protect the site from the concentrated runoff from the adjacent upland slopes after periods of heavy rainfall.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. A good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIe-1, dryland, and IIIe-4, irrigated; windbreak suitability group 3.

Ke—Kennebec silt loam, 0 to 1 percent slopes. This deep, nearly level, moderately well drained soil is on bottom land. It is subject to rare flooding. It formed in alluvium. Areas range from 10 to 100 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 7 inches thick. The subsurface layer is friable silt loam about 33 inches thick. It is very dark gray in the upper part and black in the lower part. The underlying material to a depth of more than 60 inches is very dark brown, mottled silty clay loam. In places it is more strongly expressed. In some small areas a thin layer of overwash is on the surface.

Included with this soil in mapping are small areas of Colo soils. These soils are in the slightly lower areas and are somewhat poorly drained. They make up about 5 to 15 percent of the unit.

Permeability is moderate in the Kennebec soil. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 4 feet in wet years to 6 feet in dry years. The water intake rate for irrigation is moderate. Organic matter content is high. Tilth is good.

Nearly all of the acreage is cropland. If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. The amount of available soil moisture helps to determine the proper plant population. Returning crop residue to the soil increases the rate of water intake and helps to maintain the organic matter content. Conservation tillage practices help to keep crop residue on the surface. Cultivating when the soil is too wet can cause excessive compaction. Timely tillage helps to prevent compaction and preserves soil structure. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility.

If irrigated, this soil is suited to corn, alfalfa, soybeans, and grain sorghum. Efficient management of irrigation water, including timely irrigation and tailwater recovery systems, increases productivity. Land leveling improves water distribution. Returning crop residue to the soil and applying fertilizer help to maintain fertility and good tilth.

This soil is suited to the trees and shrubs commonly grown as windbreaks. Competition from weeds and grasses is the main limitation. Seedlings generally survive and grow well if moisture is conserved and the competing vegetation is controlled or removed. The weeds and grasses can be controlled by cultivating with conventional equipment between the rows and by hand hoeing, rototilling, and applying appropriate herbicides in the rows.

The rare flooding is a hazard if this soil is used as a site for sanitary facilities or buildings. Septic tank absorption fields can be constructed on fill material, so that they are raised a sufficient distance above the seasonal high water table. The moderate permeability is a limitation, but it generally can be overcome by increasing the size of the absorption field. Seepage is a limitation on sites for sewage lagoons. It can be controlled by lining or sealing the lagoon. Constructing buildings on elevated, well compacted fill material helps to prevent the damage caused by wetness and flooding.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are I-1, dryland, and I-6, irrigated; windbreak suitability group 1.

KnB—Kennebec-Nodaway silt loams, 0 to 4 percent slopes. These deep, nearly level and very gently sloping, moderately well drained soils are on broad bottom land. They are occasionally flooded. They formed in alluvium. The topography is dominantly gently undulating. The Kennebec soil generally is in the lower, less undulating areas. The Nodaway soil generally is in or very close to the old river meanders or on the higher parts of the landscape. Areas are mainly longer than they are wide and range from 20 to 200 acres in size. They are about 65 percent Kennebec soil and about 35 percent Nodaway soil. The two soils occur as areas so closely intermingled that mapping them separately is not practical.

Typically, the Kennebec soil has a surface layer of black, very friable silt loam about 5 inches thick. The subsurface layer is very dark gray, friable silt loam about 39 inches thick. Below this is a transitional layer of very dark gray, friable silty clay loam about 12 inches thick. The underlying material to a depth of more than 60 inches is very dark grayish brown, mottled silty clay loam.

Typically, the Nodaway soil has a surface layer of very dark gray, very friable silt loam about 6 inches thick. The upper part of the underlying material to a depth of about 60 inches is stratified, dark grayish brown silt loam. The lower part is very dark grayish brown silt loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Colo and poorly drained Zook soils. These included soils are more clayey than the Kennebec and Nodaway soils. They are in low areas. They make up about 5 to 10 percent of the unit.

Permeability is moderate in the Kennebec and Nodaway soils. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 3 feet in wet years to 5 feet in dry years. The water intake rate for irrigation is moderate. Organic matter content is high in the Kennebec soil and moderate in the Nodaway soil. Tilth is good in both soils.

Nearly all of the acreage is cropland. If used for dryland farming, these soils are suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. The occasional flooding is a hazard. It may be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plains also can help to control flooding. Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. The amount of available soil moisture helps to determine the proper plant population. Returning crop residue to the soil increases the rate of water intake and helps to maintain the organic matter content. Cultivating when the soils are too wet can cause excessive compaction. Timely tillage helps to prevent compaction and preserves soil structure. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility.

If irrigated, these soils are suited to corn, alfalfa, soybeans, and grain sorghum. The occasional flooding is a hazard. It can be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on local flood plains also can help to control flooding. Sprinkler irrigation systems generally are used on these soils because of the gently undulating topography. Efficient management of irrigation water, including timely irrigation and tailwater recovery systems, increases productivity. Land leveling improves water distribution. Returning crop residue to the soil and applying fertilizer help to maintain fertility and good tilth.

These soils are suited to the trees and shrubs grown as windbreaks. Competition from weeds and grasses is the main limitation. Seedlings generally survive and grow well if moisture is conserved and the competing vegetation is controlled or removed. The weeds and grasses can be controlled by cultivating with conventional equipment between the rows and by hand hoeing, rototilling, and applying appropriate herbicides in the rows.

These soils are not suitable as sites for septic tank absorption fields or buildings because of the flooding and the wetness. A suitable alternative site is needed. Sewage lagoons should be constructed on fill material that raises the bottom of the lagoon to a sufficient height above the seasonal high water table. Also, they should be diked, so that they are protected from flooding.

Local roads and streets constructed across areas of these soils should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIw-3, dryland, and IIw-6, irrigated; windbreak suitability group 1.

MaD2—Malcolm silt loam, 5 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on side slopes in the uplands. It formed in silty deposits. In places very severe water erosion has exposed the subsoil. Areas range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 8 inches thick. The subsoil is dark brown, friable silty clay loam about 14 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray silt loam. In some areas the soil is redder.

Included with this soil in mapping are small areas of Morrill soils. These soils are redder than the Malcolm soil and formed in glacial outwash. They are in positions on the landscape similar to those of the Malcolm soil or in slightly higher positions. They make up about 5 to 15 percent of the unit.

Permeability is moderate in the Malcolm soil. Available water capacity is high. Runoff is rapid. The water intake rate for irrigation is moderate. Organic matter content is moderately low. Tilth is good.

About half of the acreage is cropland. The rest is pasture or range.

If used for dryland farming, this soil is poorly suited to corn, soybeans, small grain, and alfalfa. Further erosion is a severe hazard unless the surface is adequately protected by crops or crop residue. Sheet erosion and gullying can occur unless conservation measures are applied. Grassed waterways, contour farming and terraces on smooth slopes, and conservation tillage practices, including minimum tillage, help to prevent excessive soil loss. Returning crop residue to the soil and regularly adding organic matter improve fertility and tilth, help to control erosion, and conserve moisture.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or improper haying methods, however, reduce the extent of the protective plant cover and cause deterioration of the pasture or hayland. Proper stocking rates, a planned grazing system, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is suited to range. A cover of range plants is effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, sideoats grama, and switchgrass. When the plants are overgrazed, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats, tall dropseed, Kentucky bluestem, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, and sumac, increase in abundance.

This soil is a good site for the trees and shrubs commonly grown as windbreaks. Erosion, the slope, and excessive runoff are the main management concerns. A combination of contour planting, terraces, and cover crops between the rows helps to control erosion and runoff. Carefully applying appropriate herbicides and cultivating between the rows help to control undesirable grasses and weeds. Livestock should be excluded from the windbreak.

If this soil is used as a septic tank absorption field, land shaping and installing the absorption field on the contour help to ensure better performance. On sites for sewage lagoons, extensive grading is needed to modify the slope and shape the lagoon. Buildings should be designed so that they conform to the natural slope of the land, or the soil should be graded to an acceptable gradient.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IVe-8, dryland; windbreak suitability group 3.

McC—Marshall silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on divides and ridgetops in the uplands. It formed in loess. Areas are irregular in shape and generally are several hundred acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 4 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is dark brown in the upper part, dark yellowish brown in the next part, and brown in the lower part. The underlying material to a depth of more than 60 inches is brown silt loam. In some areas the surface layer is thinner and lighter colored.

Included with this soil in mapping are small areas of Sharpsburg soils. These soils are more clayey than the Marshall soil. Their positions on the landscape are similar to those of the Marshall soil. Also included are small areas where the slope is slightly more than 5 percent. Included areas make up 2 to 10 percent of the unit.

Permeability is moderate in the Marshall soil. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

Most of the acreage is cultivated. A few small areas are used for pasture. These areas generally are near farmsteads.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses (fig. 7). Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. Erosion and the loss of moisture through runoff are the principal management concerns. They can be controlled by conservation tillage and contour farming. Terraces help to protect the soil from concentrated runoff. Returning crop residue to the soil increases the rate of water intake and helps to maintain the content of organic matter. Tilling the soil at the right moisture content helps to prevent compaction and maintain soil structure. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility. Growing legumes also helps to maintain soil structure and porosity.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. Erosion is a hazard. Overgrazing or late haying reduces the extent of the protective plant cover. As a result, small gullies and rills can form after heavy rains. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the pasture in good condition. Timely mowing helps to control competition from weeds.

This soil is a good site for the trees and shrubs grown as windbreaks. Erosion and excessive runoff are the main hazards. They can be controlled by a combination of contour planting and terraces. Tree growth may be somewhat slower on the steepest slopes.

This soil is generally suitable as a septic tank absorption field. Seepage is a limitation if the soil is used as a site for sewage lagoons. It can be controlled by lining or sealing the lagoon. Grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to

Figure 7.—Corn in an area of Marshall silty clay loam, 2 to 5 percent slopes.

compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIe-1, dryland, and IIIe-3, irrigated; windbreak suitability group 3.

McC2—Marshall silty clay loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, well drained soil is on narrow ridgetops and the upper side slopes in the uplands. It formed in loess. Erosion has not been uniform on this soil. In most areas, however, the surface layer is lighter colored than that of the uneroded Marshall soils. Most of the original surface layer has been removed by erosion. The rest has been mixed with subsoil material by tillage. Rills are common after heavy rains. Areas range from 5 to several hundred acres in size and generally are long and narrow.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is friable silty clay loam about 32 inches thick. The upper part is dark brown, and the lower part is brown. The underlying material to a depth of more than 60 inches is brown silt loam. In some areas the surface layer is thinner and lighter colored. In other areas the subsoil contains less clay.

Included with this soil in mapping are small areas of the more clayey Sharpsburg soils. These soils are more clayey than the Marshall soil. They are in positions on the landscape similar to those of the Marshall soil. They make up 5 to 15 percent of the unit.

Permeability is moderate in the Marshall soil. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

Most of the acreage is cropland. A few small areas support grasses. These areas generally are near farmsteads.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. Further erosion and the loss of moisture through runoff are the principal management concerns. They can be controlled by conservation tillage and contour farming. Terraces help to protect the soil from concentrated runoff. Returning crop residue to the soil increases the rate of water intake and helps to maintain the content of organic matter. Tilling at the right moisture content helps to prevent compaction and maintain soil structure. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility. Growing legumes also helps to maintain soil structure and porosity.

This soil is suited to introduced grasses and legumes for pasture. Erosion is a hazard. Overgrazing or late haying reduces the extent of the protective plant cover. As a result, small gullies and rills can form after heavy rains. Overgrazing also can result in severe erosion. Proper stocking rates and rotation grazing help to maintain or improve the pasture. Applications of nitrogen fertilizer increase forage production.

This soil is a good site for the trees and shrubs grown as windbreaks. Erosion and excessive runoff are the main hazards. They can be controlled by a combination of contour planting and terraces. Tree growth may be somewhat slower on the steepest slopes.

This soil generally is suitable as a septic tank absorption field. Seepage is a limitation if the soil is used as a site for sewage lagoons. It can be controlled by lining or sealing the lagoon. Grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIe-8, dryland, and IIIe-3, irrigated; windbreak suitability group 3.

McD2—Marshall silty clay loam, 5 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on side slopes bordering intermittent drainageways in the uplands. It formed in loess. Erosion has removed most of the original surface layer. The rest has been mixed with subsoil material by tillage. Rills and gullies form during periods of heavy rainfall. Areas generally are dissected by shallow drainageways and are long and narrow. They range from 10 to 150 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 25 inches thick. The upper part is brown, and the lower part is yellowish brown. The underlying material to a depth of more than 60 inches is light brownish gray, mottled silt loam. In some areas the surface layer is somewhat thicker and darker. In other areas the subsoil is browner and contains less clay.

Included with this soil in mapping are small areas of Ida, Judson, and Sharpsburg soils. Ida soils are on the more convex parts of the side slopes. They contain less clay than the Marshall soil. Judson soils are darker than the Marshall soil. They are adjacent to drainageways.

Sharpsburg soils are more clayey than the Marshall soil. Their positions on the landscape are similar to those of the Marshall soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Marshall soil. Available water capacity is high. Runoff is rapid. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

Most of the acreage is cropland. A few small areas, especially the inaccessible ones around drainageways or gullies, are pastured.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, and grasses and legumes. Further erosion is the main hazard. Conservation tillage practices that leave crop residue on the surface help to control erosion and conserve moisture. Conservation of water is an important management concern. Terraces help to conserve surface water and control erosion. Contour farming and grassed waterways also help to control erosion (fig. 8). Improving fertility is important on this eroded soil. Applying commercial fertilizer and including legumes in the cropping sequence improve fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. Overgrazing or late haying reduces the extent of the protective plant cover. As a result, small gullies and rills can form after heavy rains. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant

Figure 8.—Contour farming in an area of Marshall silty clay loam, 5 to 11 percent slopes, eroded.

vigor and growth. Timely mowing helps to control competition from weeds.

This soil is a good site for the trees and shrubs grown as windbreaks. Erosion, excessive runoff, and competition for moisture from weeds and grasses are the main management concerns. Erosion and excessive runoff can be controlled by a combination of contour planting and terraces. Cultivating with conventional equipment, growing annual cover crops between rows, and applying appropriate herbicides in the rows help to control the undesirable weeds and grasses.

If this soil is used as a septic tank absorption field, land shaping and installing the absorption field on the contour help to ensure better performance. Seepage and slope are limitations if the soil is used as a site for sewage lagoons. Extensive grading is needed to modify the slope and shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. The buildings should be designed so that they conform to the natural slope of the land, or the soil should be graded to an acceptable gradient.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIIe-8, dryland, and IVe-3, irrigated; windbreak suitability group 3.

MeC2—Mayberry clay, 3 to 9 percent slopes, eroded. This deep, gently sloping and strongly sloping, moderately well drained soil is on side slopes and narrow ridgetops in the uplands. It formed in reworked glacial material. Erosion has removed most of the original surface layer. Rills and gullies have formed in areas where conservation measures do not protect the surface. Areas range from 5 to more than 150 acres in size.

Typically, the surface layer is dark brown, friable clay about 7 inches thick. The mottled subsoil to a depth of 60 inches or more is very firm, mottled clay. It is reddish brown in the upper part, dark brown in the next part, and brown in the lower part. In some areas the dark colors of the surface layer extend into the subsoil. In a few small areas on the concave parts of the landscape and on the lower slopes, the soil is not eroded. In places it is less reddish.

Included with this soil in mapping are small areas of Gymer and Morrill soils. Gymer soils formed in loess. They are higher on the landscape than the Mayberry soil. Morrill soils contain more sand than the Mayberry soil. Their positions on the landscape are similar to those of the Mayberry soil. Included soils make up 2 to 15 percent of the unit.

Permeability is slow in the Mayberry soil. Available water capacity is moderate. Runoff is rapid. The depth to a perched seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. Organic matter content is moderately low. The shrink-swell potential is high. Tilth is poor.

About 50 percent of the acreage is cultivated, and 50 percent is pasture or range.

If used for dryland farming, this soil generally is poorly suited to most kinds of cultivated crops. It is best suited to cool-season small grain, including oats and wheat, and to drought-resistant crops, including grain sorghum and forage sorghum. Further erosion is a hazard. Also, the claypan subsoil and moderate available water capacity limit productivity. Measures that conserve moisture, increase the organic matter content and the fertility level, and improve workability are needed. If row crops are grown year after year, controlling erosion is difficult unless a combination of special conservation practices is used. Conservation tillage, which retains most of the crop residue on the surface, increases the rate of water intake, conserves moisture, adds organic matter, and helps to prevent excessive erosion. Terracing and farming on the contour also help to prevent excessive erosion. Grassed waterways carry excess water from the fields without eroding the drainageways. If these conservation measures are not applied, the soil can be protected by growing clean-cultivated row crops only on a limited basis and by including a maximum of close-growing small grain, legumes, or legume-grass mixtures in the cropping sequence. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Timely tillage helps to prevent compaction and preserves soil structure. Applying barnyard manure and commercial fertilizers, such as phosphate, nitrogen, and lime, improves fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control weeds.

This soil is suited to range. A cover of range plants is effective in controlling erosion. The natural plant community is dominated by big bluestem, indiangrass, little bluestem, switchgrass, and sideoats grama. When the plants are overgrazed, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, tall dropseed, buckbrush, and snowberry, increase in abundance. Range seeding may be needed to stabilize severely eroded cropland.

This soil is a poor site for the trees and shrubs grown as farmstead or feedlot windbreaks and as plantings that enhance recreation areas and wildlife habitat. It generally is not suited to field windbreaks. The survival and growth rates of adapted species are fair. The high clay content, drought, and competition from weeds and grasses are management concerns. The site should be prepared for planting when the soil is moist, but not when it is wet. Tillage or a combination of chemicals and tillage can be used to prepare the site. Supplemental watering can provide the water needed during periods of insufficient moisture. Cultivating with conventional equipment, growing annual cover crops between the rows, and applying appropriate herbicides in the rows help to control undesirable weeds and grasses. In some areas hand hoeing or rototilling is needed.

Because of the slow permeability and the wetness, this soil generally is unsuitable as a septic tank absorption field. A suitable alternative site is needed. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Constructing the buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing

coarser grained base material helps to ensure better performance. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The capability unit is IVe-4, dryland; windbreak suitability group 4C.

MmC2—Monona silt loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, well drained soil is on narrow ridgetops and the upper side slopes in the uplands. It formed in loess. Most of the original surface layer has been removed by erosion. The rest has been mixed with subsoil material by tillage. Areas generally are long and narrow and range from 5 to 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsoil is friable silt loam about 32 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The underlying material to a depth of more than 60 inches is yellowish brown, mottled silt loam. On the wider ridges the surface layer is slightly thicker. In some areas the subsoil contains more clay.

Permeability is moderate. Available water capacity is high. Runoff is medium. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

Most of the acreage is cropland. A few small areas are pastured. These areas generally are near farmsteads.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, and oats and to alfalfa, clover, and grasses for hay or pasture. Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. Erosion and the loss of moisture through runoff are the principal hazards. They can be controlled by contour farming and conservation tillage practices, such as chiseling, disking, or till planting. Terraces help to protect the soil from concentrated runoff. Returning crop residue to the soil increases the rate of water intake and helps to maintain the content of organic matter. Tilling at the right moisture content helps to prevent compaction and maintain soil structure. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility. Growing legumes also helps to maintain soil structure and porosity.

This soil is suited to introduced grasses and legumes for pasture. A cover of these plants is effective in controlling erosion. Overgrazing or late haying reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Overgrazing also can result in severe erosion. Proper stocking rates and rotation grazing help to maintain or improve the pasture. Applications of nitrogen fertilizer increase forage production.

This soil is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival and growth rates of adapted species are good. Competition for moisture from weeds and grasses is the main limitation. Erosion is a minor hazard. Seedlings generally survive and grow well if moisture is conserved and the competing vegetation is controlled or removed. Cultivating between the rows with conventional equipment and hand hoeing, rototilling, and applying appropriate herbicides in the rows conserve moisture and help to control weeds and grasses. Planting on the contour helps to control erosion.

This soil generally is suitable as a septic tank absorption field. Seepage is a limitation if the soil is used as a site for sewage lagoons. It can be controlled by sealing or lining the lagoon. Grading is needed to modify the slope and shape the lagoon. Strengthening the foundation of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIe-8, dryland, and IIIe-6, irrigated; windbreak suitability group 3.

MmD2—Monona silt loam, 5 to 11 percent slopes, eroded. This deep, well drained, strongly sloping soil is on side slopes bordering intermittent drainageways in the uplands. It formed in loess. Erosion has removed most of the original surface layer. The rest is being mixed with subsoil material by tillage. Rills and gullies form during periods of heavy rainfall. Areas generally are dissected by shallow drainageways and are long and narrow. They range from 10 to 150 acres in size.

Typically, the surface layer is dark brown, friable silt loam about 7 inches thick. The subsoil is friable silt loam about 28 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The underlying material to a depth of about 60 inches is mottled silt loam. The upper part is dark yellowish brown, and the lower part is yellowish brown. In places, the soil is slightly more clayey and the structure of the subsoil is slightly more strongly expressed.

Included with this soil in mapping are small areas of Ida and Judson soils. The calcareous Ida soils are in convex, eroded areas. They are lighter colored than the

Monona soil. Judson soils are along drainageways in the lower areas. They have a thick, dark surface layer. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Monona soil. Available water capacity is high. Runoff is medium. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

Most of the acreage is cropland. A few small areas, especially the inaccessible ones around drainageways and gullies, are pastured.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, and grasses and legumes. Further erosion is the main hazard, and conservation of water is an important management concern. Terraces and conservation tillage practices, such as chiseling, disking, or till planting, that leave crop residue on the surface help to control erosion and conserve moisture. Contour farming and grassed waterways also help to control erosion. Improving fertility by applying commercial fertilizer and including legumes in the cropping sequence is important on this eroded soil.

This soil is suited to introduced grasses for pasture, such as smooth brome or a mixture smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is suited to the trees and shrubs grown as windbreaks. The slope and the erosion hazard are the main management concerns. Carefully applying appropriate herbicides and cultivating between the trees help to control grasses and weeds, which are highly competitive with the young trees. Erosion and the loss of moisture through runoff can be controlled by planting a cover crop between the rows or by planting trees on the contour and terracing. The trees should be protected from livestock.

If this soil is used as a septic tank absorption field, land shaping and installing the absorption field on the contour help to ensure better performance. Seepage and slope are limitations if the soil is used as a site for sewage lagoons. Sealing or lining the lagoon helps to prevent seepage. Grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. The buildings should be designed so that they conform to the natural slope of the land, or the soil should be graded to an acceptable gradient.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIIe-8, dryland, and IVe-6, irrigated; windbreak suitability group 3.

MnD2—Monona-Ida silt loams, 5 to 11 percent slopes, eroded. These deep, strongly sloping, well drained soils are on long, convex side slopes in the uplands. The Monona soil is on the longer, less convex slopes, and the Ida soil is on the more convex slopes on the upper parts of the landscape. Both soils formed in loess. Erosion has removed most of the original surface layer. The rest is being mixed with the subsoil or underlying material by tillage. In areas where the surface is not protected by conservation measures, rills and gullies form during periods of heavy rainfall. Areas generally are dissected by shallow drainageways and are long and narrow. They range from 10 to 200 acres in size. They are 35 to 65 percent Monona soil and 35 to 65 Ida soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Monona soil has a surface layer of dark brown, friable silt loam about 10 inches thick. The subsoil is friable silt loam about 18 inches thick. The upper part is dark yellowish brown, and the lower part is brown. The underlying material to a depth of more than 60 inches is yellowish brown, mottled silt loam. In some areas the subsoil contains more clay.

Typically, the Ida soil has a surface layer of brown, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is brown, calcareous silt loam. In some areas it has many large concretions of lime.

Included with these soils in mapping are small areas of Judson soils on foot slopes. These included soils have a dark surface layer that is more than 24 inches thick. They make up 5 to 10 percent of the map unit.

Permeability is moderate in the Monona and Ida soils. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is moderate. Organic matter content is moderate in the Monona soil and low in the Ida soil. The Ida soil is calcareous throughout, and the Monona soil is calcareous below a depth of about 25 inches. The Ida soil may be deficient in phosphorus because of the high content of calcium carbonate. The shrink-swell potential is moderate in the Monona soil. Tilth is good in both soils.

Most of the acreage is cultivated. Some small areas are pastured.

If used for dryland farming, these soils are suited to corn, grain sorghum, small grain, and alfalfa. Further erosion is a hazard. It can be controlled by grassed

waterways, contour farming, and terraces. Conservation tillage practices, such as chiseling, disking, and till planting, that return crop residue to the soil help to control erosion, conserve moisture, and add organic matter. Applying commercial fertilizer, especially phosphorus, improves the fertility of these light colored, eroded soils.

These soils are suited to introduced grasses and legumes for pasture. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Overgrazing also can result in severe erosion. Proper stocking rates and rotation grazing help to maintain or improve the pasture. Applications of nitrogen fertilizer increase forage production.

These soils are good sites for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival and growth rates of adapted species are fair. Erosion, excessive runoff, and the high content of calcium are management concerns. Only the species that can withstand an excess amount of carbonates should be selected for planting. A combination of contour planting and terracing helps to prevent excessive runoff and erosion. Carefully applying selected herbicides and cultivating between the rows help to control grasses and weeds, which can choke out seedlings. The windbreaks should be protected from livestock. Tree growth may be somewhat slower on the steepest slopes.

If these soils are used as septic tank absorption fields, land shaping and installing the absorption fields on the contour help to ensure better performance. Seepage and slope are limitations on sites for sewage lagoons. Grading is needed to modify the slope and shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to an acceptable gradient. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of these soils should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIIe-8, dryland, and IVe-6, irrigated. The Monona soil is in windbreak suitability group 3, and the Ida soil is in windbreak suitability group 8.

MnE2—Monona-Ida silt loams, 11 to 17 percent slopes, eroded. These deep, moderately steep, well drained soils are on long, convex side slopes in the uplands. The Monona soil is on the longer, less convex slopes, and the Ida soil is on the more convex slopes on the upper parts of the landscape. Both soils formed in loess. Erosion has removed most of the original surface layer. The rest is being mixed with the subsoil or underlying material by tillage. In areas where the surface is not protected by conservation measures, rills and gullies form during periods of heavy rainfall. Areas generally are dissected by shallow drainageways and are long and narrow. They range from 5 to 100 acres in size. They are 35 to 65 percent Monona soil and 35 to 65 percent Ida soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Monona soil has a surface layer of dark brown, friable silt loam about 6 inches thick. The subsoil is friable silt loam about 21 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The underlying material to a depth of more than 60 inches is light brownish gray, mottled, calcareous silt loam. In some areas the soil is deeper to lime and contains more clay in the subsoil.

Typically, the Ida soil has a surface layer of dark brown, calcareous, friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is brown, calcareous, friable silt loam. It has calcium concretions and relic mottles throughout.

Included with these soils in mapping are small areas of Judson soils on foot slopes. These included soils have a dark surface layer that is more than 24 inches thick. Also included are a few areas of glacial till, limestone, or shale on the lower slopes. Included areas make up around 5 percent of the map unit.

Permeability is moderate in the Monona and Ida soils. Available water capacity is high. Runoff is medium. Organic matter content is moderate in the Monona soil and low in the Ida soil. The Ida soil is calcareous throughout, and the Monona soil is calcareous below a depth of about 27 inches. The Ida soil may be deficient in phosphorus because of the high content of calcium carbonate. The shrink-swell potential is moderate in the Monona soil. Tilth is good in both soils.

Most of the acreage is cultivated. Some small areas are pastured.

If used for dryland farming, these soils are poorly suited to grain sorghum, small grain, and alfalfa. Further erosion is a severe hazard. It can be controlled by grassed waterways, contour farming, and terraces. Conservation tillage practices, such as chiseling, disking, and till planting, that return crop residue to the soil help to control erosion, conserve moisture, and add organic matter. Applying commercial fertilizer, especially phosphorus, improves the fertility of these light colored, eroded soils.

These soils are suited to introduced grasses and legumes for pasture. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Overgrazing also can result in severe erosion. Proper stocking rates and rotation grazing help to maintain or improve the pasture. Applications of nitrogen fertilizer increase forage production.

These soils are suited to the trees and shrubs grown as windbreaks. The species that are adapted to limy soils grow well. Erosion is a hazard. Competition for moisture from grasses and weeds limits the establishment of seedlings. Planting on the contour and growing cover crops between the rows help to prevent excessive erosion. Carefully applying selected herbicides and cultivating between the rows help to control grasses and weeds, which can choke out seedlings. The windbreaks should be protected from livestock.

These soils generally are not suitable as sites for sanitary facilities because of the moderately steep slope. A suitable alternative site is needed. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to an acceptable gradient. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of these soils should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage. Cutting and filling generally are needed to provide a suitable grade.

The capability unit is IVe-8, dryland. The Monona soil is in windbreak suitability group 3, and the Ida soil is in windbreak suitability group 8.

MnF2—Monona-Ida silt loams, 17 to 30 percent slopes, eroded. These deep, steep, well drained soils are on side slopes in the uplands, mainly on the bluffs that border the valley of the Missouri River. The soils formed in loess. The Monona soil is on the more concave slopes, and the Ida soil is on the more convex slopes on the higher parts of the landscape. Areas generally are dissected by deeply entrenched drainageways. They are about 50 to 60 percent Monona soil and 30 to 40 percent Ida soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Monona soil has a surface layer of dark brown, friable silt loam about 6 inches thick. The subsoil is brown, friable silt loam about 39 inches thick. The underlying material to a depth of more than 60 inches is brown, mottled silt loam. In some areas the surface layer is thicker.

Typically, the Ida soil has a surface layer of brown, friable silt loam about 6 inches thick. The underlying material to a depth of more than 60 inches is yellowish brown, calcareous silt loam. It is mottled in the lower part.

Included with these soils in mapping are small areas of the dark Judson soils adjacent to drainageways. Also included, on ridges, are long, very narrow areas of Monona soils that have a slope of 4 to 10 percent. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Monona and Ida soils. Available water capacity is high. Runoff is rapid. Organic matter content is moderate in the Monona soil and low in the Ida soil. The Ida soils may be deficient in both nitrogen and phosphorus. Tilth is good in both soils.

Most of the acreage supports grasses or trees. A few areas along the outer edges of the map unit are cultivated or formerly were cultivated. The areas of grasses or trees are used mainly as range or as wildlife habitat. Some timber is harvested from the oak, hickory, and walnut trees that grow in these areas.

Because of the steep uneven slopes and a severe hazard of further erosion, these soils are unsuited to cultivation. They are suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

These soils are suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

These soils generally are unsuited to windbreaks. Adapted species of trees and shrubs grow fairly well, but the steep slope limits the use of planting and cultivating equipment. The trees and shrubs can be hand planted if other special management is applied.

If these soils are used as sites for native woodlots, livestock should be fenced out of the stands, the less desirable trees should be removed, and measures that

improve the stands should be applied. Small areas can be left undisturbed and used as habitat for wildlife.

These soils are well suited to wildlife habitat. They support a wide variety of plants that provide cover and food for range and woodland wildlife. The main threat to wildlife production is the destruction of habitat resulting from indiscriminate burning and other practices.

These soils generally are not suitable as sites for sanitary facilities or buildings because of the steep slope. A suitable alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage. Cutting and filling generally are needed to provide a suitable grade.

The capability unit is VIe-8, dryland; windbreak suitability group 10.

MnG—Monona-Ida silt loams, 30 to 60 percent slopes. These deep, very steep, well drained soils are on side slopes in the uplands, mainly on the bluffs that border the valley of the Missouri River. The soils formed in loess. The Monona soil is on the more concave slopes, and the Ida soil is on the more convex slopes on the upper parts of the landscape. Areas generally are dissected by deeply entrenched drainageways. They are irregular in shape and range from 40 to several hundred acres in size. They are about 50 to 55 percent Monona soil and 40 to 45 percent Ida soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Monona soil has a surface layer of very dark grayish brown, friable silt loam about 10 inches thick. The subsoil is friable silt loam about 35 inches thick. The upper part is dark brown, and the lower part is brown. The underlying material to a depth of more than 60 inches is yellowish brown, mottled silt loam. In some areas the surface layer is thinner.

Typically, the Ida soil has a surface layer of dark brown, friable silt loam about 5 inches thick. The underlying material to a depth of more than 60 inches is yellowish brown, calcareous silt loam. In the lower part it is mottled and has accumulations of lime. In some areas the surface layer is calcareous.

Included with these soils in mapping are small areas of the dark Judson soils adjacent to drainageways. Also included, on ridges, are small areas of Monona soils that have a slope of 2 to 6 percent. Included soils make up less than 5 percent of the unit.

Permeability is moderate in the Monona and Ida soils. Available water capacity is high. Runoff is very rapid. Organic matter content is moderate in the Monona soil and low in the Ida soil. The Ida soil may be deficient in both nitrogen and phosphorus. Tilth is good in both soils.

Most areas support an oak-hickory type of tree cover and an understory of blue grass, forbs, and woody shrubs (fig. 9). These areas are used as wooded pasture or as habitat for wildlife. These soils are unsuited to cultivation because they are very steep.

If these soils are used as sites for native woodlots, livestock should be fenced out of the stands, the less desirable trees should be removed, and measures that improve the stands should be applied. Small areas can be left undisturbed and used as habitat for wildlife.

These soils are well suited to wildlife habitat. They support a wide variety of plants that provide cover and food for range and woodland wildlife. The main threat to wildlife production is the destruction of habitat resulting from indiscriminate burning and other practices.

These soils generally are not suitable as sites for sanitary facilities or buildings because of the very steep slope. A suitable alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage. Cutting and filling generally are needed to provide a suitable grade.

The capability unit is VIIe-1, dryland; windbreak suitability group 10.

MpG—Monona-Kipson complex, 30 to 70 percent slopes. These very steep soils are mainly on the bluffs that border the valley of the Missouri River. They generally are dissected by deeply entrenched drainageways. The deep, well drained Monona soils formed in loess, generally on the higher parts of the landscape. The shallow or very shallow, somewhat excessively drained Kipson soil formed in shaly residuum on the lower parts of the landscape. Areas range from 40 to several hundred acres in size and generally are long and narrow. They are about 50 to 70 percent Monona soil and 30 to 50 percent Kipson soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Monona soil has a surface layer of very dark grayish brown, friable silt loam about 10 inches thick. The subsoil is friable silt loam about 29 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The underlying material to a depth of more than 60 inches is mottled silt loam. It is dark brown in the upper part and brown in the lower part.

Typically, the Kipson soil has a surface layer of black, friable, calcareous silty clay loam about 7 inches thick. Below this is a transitional layer of very dark grayish

Figure 9.—Oak and other trees in an area of Monona-Ida silt loams, 30 to 60 percent slopes, on the breaks along the Missouri River.

brown, friable, calcareous silty clay loam about 5 inches thick. A thin layer of fractured limestone is at a depth of about 12 inches. The upper part of the bedrock is pale brown cherty limestone, and the lower part is gray, very firm platy shale. In a few areas the depth to shale is either less than 7 inches or more than 20 inches.

Included with these soils in mapping are small areas of the frequently flooded Nodaway soils in and adjacent to drainageways. Also included, on narrow ridges, are small areas of Monona soils that have a slope of 2 to 6 percent, too small to delineate. Included soils make up 2 to 10 percent of the unit.

Permeability is moderate in the Monona and Kipson soils. Available water capacity is high in the Monona soil and low in the Kipson soil. Runoff is very rapid on both soils. Organic matter content is moderate.

Most areas support an oak-hickory type of tree cover and an understory of bluegrass, forbs, and woody shrubs. These areas are used as wooded pasture or as habitat for wildlife. These soils are unsuitable for cultivation because they are very steep.

If these soils are used as sites for native woodlots, livestock should be fenced out of the stands, the less desirable trees should be removed, and measures that improve the stands should be applied. Small areas can be left undisturbed and used as habitat for wildlife.

These soils are well suited to wildlife habitat. They support a wide variety of plants that provide cover and food for range and woodland wildlife. The main threat to wildlife production is the destruction of habitat.

These soils generally are not suitable as sites for buildings or sanitary facilities because they are very steep and because the Kipson soil is shallow or very shallow over bedrock. A suitable alternative site is needed. Constructing local roads and streets on ridgetops or near drainageways helps to eliminate the need for excessive cutting and filling. Low strength and frost action are limitations in areas of the Monona soil. Installing a good surface drainage system helps to prevent the damage caused by frost action. The roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

The capability unit is VIIe-1, dryland; windbreak suitability group 10.

MrD2—Morrill clay loam, 5 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on uplands. It generally is in long, narrow areas on long, even side slopes or in small, circular or crescent-shaped areas on the nose of ridges. The soil formed in glacial outwash. Erosion has removed some of the surface layer. Rills and gullies form during periods of heavy rainfall. Areas range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 9 inches thick. The subsoil is about 24 inches thick. The upper part is reddish brown, firm clay loam, the next part is dark brown, firm sandy clay loam, and the lower part is brown, friable sandy clay loam. The upper part of the underlying material is brown clay loam. The lower part to a depth of more than 60 inches is yellowish brown loam. Stones and pebbles are throughout the soil. In some areas the dark surface layer is thicker. In a few areas the subsoil has more sand. In places large boulders are on the surface.

Included with this soil in mapping are small areas of Gymer, Malcolm, and Mayberry soils. Gymer and Mayberry soils contain more clay in the subsoil than the Morrill soil. Also, they are higher on the landscape. Malcolm soils are siltier throughout than the Morrill soil. Their positions on the landscape are similar to those of the Morrill soil. Also included are a few sandy spots in the most eroded areas. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Morrill soil. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential is moderate in the subsoil. Tilth is fair.

About half of the acreage is cropland. The rest is pasture or range.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, and alfalfa. Further erosion is a hazard. A conservation tillage system, such as stubble mulching, that leaves crop residue on or near the surface, helps to control erosion, conserves moisture, helps to maintain or improve fertility and tilth, and increases the organic matter content. Applying commercial fertilizers helps to maintain a high fertility level.

This soil is suited to introduced grasses for pasture, generally bromegrass or a mixture of bromegrass and alfalfa or orchardgrass and alfalfa. A cover of these plants is very effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the pasture in good condition. Timely mowing helps to control competition from weeds.

This soil is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

This soil is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival and growth rates of adapted species are good. Erosion, the slope, and excessive runoff are the main management concerns. Cultivating between the rows with conventional equipment, growing annual cover crops between the rows, and carefully applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Areas in the row or near small trees can be hoed by hand or rototilled. Planting on the contour and terracing help to prevent excessive erosion and runoff. Tree growth may be somewhat slower on the steepest slopes.

The moderate permeability is a limitation if this soil is used as a septic tank absorption field. This limitation generally can be overcome, however, by increasing the size of the absorption field. Land shaping and installing the absorption field on the contour help to ensure better performance. On sites for sewage lagoons, extensive grading is needed to modify the slope and shape the lagoon. Buildings should be designed so that they

conform to the natural slope of the land, or the soil should be graded to an acceptable gradient. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage. Cutting and filling generally are needed to provide a suitable grade.

The capability unit is IVe-8, dryland; windbreak suitability group 3.

Mv—Moville silt loam, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad bottom land in the valley of the Missouri River. It is occasionally flooded. It formed in silty alluvium over clayey alluvium. Areas range from 20 to 100 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 7 inches thick. The upper 21 inches of the underlying material is stratified very dark grayish brown and dark grayish brown, mottled, very friable silt loam. The lower part to a depth of more than 60 inches is black, firm silty clay. In some areas the silty layer is thinner.

Included with this soil in mapping are small areas of Albaton and Nodaway soils. The poorly drained Albaton soils are in the lower areas. They are clayey throughout. The moderately well drained Nodaway soils are in the slightly higher areas. They are silty throughout. Included soils make up 2 to 10 percent of the unit.

Permeability is moderate in the upper part of the Moville soil and very slow in the lower part. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges about 1 foot in wet years to 3 feet in dry years. The water intake rate for irrigation is moderate. Organic matter content also is moderate. The shrink-swell potential is high in the lower part of the underlying material. Tilth is good.

Most of the acreage is cropland. Some small areas support native trees and introduced grasses.

If used for dryland farming, this soil is suited to soybeans, corn, grain sorghum, and introduced grasses. The wetness is the principal limitation. Grain sorghum and soybeans are better suited than corn because they can be planted later in the spring. Also, corn may be adversely affected by hot, dry periods in the summer, when the plants are in critical stages of development. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Filling in low areas and establishing a general land grade help to drain surface water. In places surface ditches are feasible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Returning crop residue to the soil increases the content of organic matter and improves soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, soybeans, and grain sorghum and to grasses and legumes for hay and pasture. Land leveling improves surface drainage and helps to achieve a uniform distribution of water in areas irrigated by a gravity system. Cutting into the clayey part of the underlying material should be avoided as much as possible because establishing seedlings and tilling are difficult if this clayey material is exposed. Sprinkler irrigation can help seedlings to penetrate a crusted surface layer. Adding zinc and organic matter improves fertility and tilth in the crusted areas. Applying water at a rate suited to the moderate water intake rate of the soil helps to control runoff of irrigation water. If a gravity irrigation system is used, the water should be applied more often on this soil than on soils that have a higher intake rate. Also, the length of the run should be longer. A tailwater recovery system conserves water.

This soil is suited to introduced grasses for pasture, such as a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. Excessive wetness limits the choice of pasture grasses and legumes. Grazing when the water table is highest results in damage to the grass stand, a rough surface, and difficulty in mowing for hay. Because of the wetness, seeding the grasses can be difficult. A drainage system of V-ditches or perforated tile reduces the wetness. Proper grazing use, proper stocking rates, and rotation grazing help to keep the pasture in good condition. Applying nitrogen fertilizer increases forage production and plant vigor. Timely mowing helps to control competition from weeds.

This soil generally is a good site for the trees and shrubs grown as windbreaks if the species that can withstand the occasional wetness are selected for planting. Establishing seedlings is difficult in wet years. Timely cultivation and weed control are management concerns. Weeds can be controlled by cultivating with conventional equipment before and after the trees or shrubs are planted and by carefully applying selected herbicides. In some years cultivating and planting should be postponed because the soil is too wet.

Some areas of this soil, especially those adjacent to or near the Missouri River, support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suitable as a site for septic tank absorption fields or buildings because of the flooding, the wetness, and the very slow permeability. A suitable

alternative site is needed. Sewage lagoons should be constructed on fill material that raises the bottom of the lagoon a sufficient height above the seasonal high water table. Also, they should be diked, so that they are protected from flooding.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIw-2, dryland and irrigated; windbreak suitability group 2S.

Nc—Nodaway silt loam, 0 to 1 percent slopes. This deep, nearly level, moderately well drained soil is on bottom land and adjacent to upland streams and drainageways. It is occasionally flooded. It formed in silty alluvium. Areas range from 10 to 300 acres in size and generally are long, continuous strips.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is very dark grayish brown and grayish brown in the upper part and stratified very dark gray and grayish brown in the lower part. In some areas the fine stratification is not evident.

Included with this soil in mapping are small areas of Zook soils. These soils are more clayey than the Nodaway soil. Also, they are lower on the landscape. They make up 2 to 10 percent of the unit.

Permeability is moderate in the Nodaway soil. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 3 feet in wet years to about 5 feet in dry years. The water intake rate for irrigation is moderate. Organic matter content also is moderate. Tilth is good. The soil can be easily tilled throughout a wide range in moisture content.

Nearly all of the acreage is cultivated. Small tracts along stream channels support native grasses or trees and are used mainly as habitat for wildlife or as range.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, forage sorghum, and grasses. The occasional flooding is a hazard. The floodwater generally recedes within a few hours, however, and crops are seldom severely damaged. Row crops, such as corn, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. Flooding can be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. Applying a system of conservation tillage and returning crop residue to the soil help to maintain the rate of water intake and the content of organic matter and conserve moisture. Applying fertilizer improves or maintains fertility.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. The occasional flooding following periods of heavy rainfall or spring thaws is the main hazard. It is of short duration, however, and seldom severely damages crops. Establishing diversions and dikes on the local flood plain helps to control the floodwater. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface help to control soil blowing and conserve moisture. Land leveling improves surface drainage and increases the efficiency of irrigation systems. Irrigation water should be applied in a timely and efficient manner. A tailwater recovery system conserves water.

This soil is suited to range and native hay. The natural plant community is mostly mid and tall grasses and grasslike plants dominated by big bluestem, little bluestem, switchgrass, and various sedges. When the plants are overgrazed or improperly harvested for hay, the site may be dominated by Kentucky bluegrass, sedges, and numerous annual and perennial weeds. Also, woody plants including snowberry and buckbrush, invade the site. Brush management may be needed to control these plants.

This soil generally is a good site for the trees and shrubs grown as windbreaks. Competition from weeds and grasses is the main limitation. Seedlings generally survive and grow well if moisture is conserved and the competing vegetation is controlled or removed. The weeds and grasses can be controlled by cultivating with conventional equipment between the rows and by hand hoeing, rototilling, and carefully applying appropriate herbicides in the rows.

This soil is not suitable as a site for sanitary facilities or buildings because of the flooding. A suitable alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIw-3, dryland, and IIw-6, irrigated; windbreak suitability group 1.

Nf—Nodaway silt loam, channeled. This deep, very gently sloping, moderately well drained soil is on bottom land. In some areas it is adjacent to the Little Nemaha River. It is frequently flooded. It formed in silty alluvium. Areas generally are highly dissected by streams and deep drainageways and are long, narrow, and continuous. They range from 10 to 150 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 8 inches thick. The underlying material to a depth of more than 60 inches is silt loam. It is very dark gray and grayish brown in the upper part and black in the lower part. In some areas a dark buried soil is within a depth of 36 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Colo soils. These soils contain more clay throughout than the Nodaway soil. Their positions on the landscape are similar to those of the Nodaway soil. Also included are a few areas of poorly drained soils. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderate in the Nodaway soil. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 3 feet in wet years to about 5 feet in dry years. Organic matter content is moderate. The soil is so channeled that it cannot be crossed by farm equipment. Tilth is good.

Most of the acreage supports native grass or trees. It is used for grazing or as habitat for wildlife. This soil is not suited to cultivated crops or windbreaks because it is frequently flooded and commonly is inaccessible to modern farm equipment.

This soil is suited to range. The natural plant community is mostly mid and tall grasses and grasslike plants dominated by big bluestem, little bluestem, switchgrass, and various sedges. When the plants are overgrazed or improperly harvested for hay, the site may be dominated by Kentucky bluegrass, sedges, and numerous annual and perennial weeds. Also, woody plants, including snowberry and buckbrush, invade the site. Brush management may be needed to control these plants.

The potential of this soil for woodland wildlife habitat is good if the native vegetation is left undisturbed.

This soil is not suitable as a site for sanitary facilities or buildings because of the flooding. A suitable alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage. Bridges commonly are needed across the channeled areas.

The capability unit is VIw-7, dryland; windbreak suitability group 10.

Ng—Nodaway-Colo silt loams, 0 to 2 percent slopes. These deep, nearly level soils are on bottom land. Commonly, the moderately well drained Nodaway soil is in the slightly higher areas adjacent to stream channels, and the somewhat poorly drained Colo soil is in the lower areas away from the channels. Both soils are occasionally flooded. They formed in silty alluvium. The stream channels range from crooked to straight and from deeply cut to shallow. Areas are narrow, long, and continuous and generally range from 20 to several hundred acres in size. They are about 40 to 60 percent Nodaway soil and 40 to 60 percent Colo soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Nodaway soil has a surface layer of very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is black, friable silt loam about 12 inches thick. The underlying material to a depth of more than 60 inches is very dark grayish brown and dark grayish brown silt loam.

Typically, the Colo soil has a surface layer of very dark gray, friable silt loam about 9 inches thick. The subsurface layer is about 21 inches thick. The upper part is black, friable silt loam, and the lower part is very dark gray, firm silty clay loam. The underlying material to a depth of more than 60 inches is very dark grayish brown and dark grayish brown, mottled silty clay loam. In some areas where siltation is common, finely stratified silt loam sediments 10 to 18 inches thick are deposited on the original dark surface layer. In other areas the soil consists of stratified silty clay loam sediments of recent deposition.

Included with these soils in mapping are small areas of Judson and Zook soils. Judson soils are not stratified. They are higher on the landscape than the Nodaway and Colo soils. Zook soils are poorly drained and are in the slightly lower areas. Included soils make up about 5 to 15 percent of this unit.

Permeability is moderate in the Nodaway and Colo soils. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table in the Colo soil ranges from 1 foot in wet years to about 3 feet in dry years. The depth to the seasonal high water table in the Nodaway soil ranges from 3 feet in wet years to about 5 feet in dry years. The water intake rate for irrigation is moderate in the Nodaway soil and low in the Colo soil. The shrink-swell potential and the content of organic matter are moderate in the Nodaway soil and high in the Colo soil. Tilth is good in both soils.

About 50 percent of the acreage is cultivated, and 50 percent supports grasses or trees and is used mainly as pasture. Reed canarygrass, willows, and cottonwoods are the most common plants, especially along the stream channels and waterways.

If used for dryland farming, these soils are suited to corn, grain sorghum, soybeans, forage sorghum, and grasses. The seasonal high water table is the main limitation, and the flooding is the principal hazard. Row crops, such as corn, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. Establishing grassed waterways that have a designed depth and grade, land leveling, or leveling and installing drainage tile help to overcome the wetness. Flooding can be controlled by terraces and conservation tillage on the adjoining uplands and by flood-control structures. Returning crop residue to the soil helps to maintain the organic matter content and the rate of water intake. Excessive compaction is a problem if the soils are tilled when they are too wet. Timely tillage helps to prevent compaction and preserves soil structure.

These soils generally are good sites for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survivial rate of adapted species is good. Establishing seedlings can be difficult during wet years. Tillage and planting should be deferred until after the soils have begun to dry. Only the species that can withstand the occasional wetness should be selected for planting. Weeds and grasses can be controlled by cultivating with conventional equipment and growing annual cover crops between the rows and by applying appropriate herbicides in the rows. Areas near trees can be hoed by hand or rototilled.

These soils are suited to range and native hay. The natural plant community is mostly mid and tall grasses dominated by big bluestem, little bluestem, switchgrass, and various sedges. When the plants are overgrazed or improperly harvested for hay, the site may be dominated by sedges, Kentucky bluegrass, redtop, and numerous annual and perennial weeds.

These soils are suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

These soils are not suitable as a site for sanitary facilities or buildings because of the flooding and the wetness. A suitable alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIw-3, dryland, and IIw-6, irrigated. The Nodaway soil is in windbreak suitability group 1, and the Colo soil is in windbreak suitability group 2S.

Oc—Onawa silt loam, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad bottom land in the valley of the Missouri River. It is occasionally flooded. It formed in clayey and silty alluvium. Areas range from 20 to 120 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The upper part of the underlying material is dark grayish brown and very dark grayish brown, mottled, friable silt loam. The next part is dark grayish brown and very dark grayish brown, mottled, very firm, calcareous silty clay. The lower part to a depth of more than 60 inches is dark olive gray and dark grayish brown, friable, calcareous silt loam and very fine sandy loam. In some areas the surface layer is silty clay or silty clay loam.

Included with this soil in mapping are small areas of the poorly drained Albaton soils in the slightly lower landscape positions and small areas of Moville soils. Moville soils are in positions on the landscape similar to those of the Onawa soil. Their upper layer of silty material is thicker than that of the Onawa soil. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the upper part of the Onawa soil and moderate in the lower part. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from about 2 feet in wet years to 4 feet in dry years. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential is low in the surface layer, high in the middle part of the underlying material, and low in the lower part. Tilth is good.

Most of the acreage is cropland. Some small areas support native trees and introduced grasses.

If used for dryland farming, this soil is suited to soybeans, corn, grain sorghum, and introduced grasses. The flooding is a hazard, and the wetness is the principal limitation. The flooding is controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plains also can help to control flooding. Grain sorghum and soybeans are better suited than corn because they can be planted later in

the spring. Also, corn may be adversely affected by hot, dry periods in the summer, when the plants are in critical stages of development. The soil holds moisture tightly and does not release it fast enough to maintain the corn plants. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Filling low areas and establishing a general land grade help to drain surface water. In places surface ditches are feasible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Returning crop residue to the soil increases the content of organic matter and improves soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, soybeans, and grain sorghum and to grasses and legumes for hay and pasture. Land leveling improves surface drainage and helps to achieve a uniform distribution of water if a gravity irrigation system is used. Cutting into the clayey part of the underlying material should be avoided as much as possible because establishing seedlings and tilling are difficult if this material is exposed. Sprinkler irrigation can help seedlings to penetrate a crusted surface layer. Adding zinc and organic matter improves fertility and tilth in the crusted areas. Applying water at a rate suited to the low water intake rate of the soil helps to control runoff of irrigation water. If a gravity irrigation system is used, the water should be applied more often than it is applied to soils that have a moderately low or moderate intake rate. Also, the length of the run should be longer. A tailwater recovery system conserves water.

This soil is suited to introduced grasses for pasture, such as a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. Excessive wetness limits the choice of pasture grasses and legumes. Grazing when the water table is highest results in damage to the grass stand, a rough surface, and difficulty in mowing for hay. Because of the wetness, seeding the grasses can be difficult. A drainage system of V-ditches or perforated tile reduces the wetness caused by the high water table. Proper grazing use, proper stocking rates, and rotation grazing help to keep the pasture in good condition. Applying nitrogen fertilizer increases forage production and plant vigor. Timely mowing helps to control competition from weeds.

This soil generally is a good site for the trees and shrubs grown as windbreaks if the species selected for planting are those that can withstand the occasional wetness. Establishing seedlings is difficult in wet years. Timely cultivation and weed control are management concerns. Weeds and grasses can be controlled by cultivating with conventional equipment before and after the trees or shrubs are planted and by applying carefully selected herbicides. In some years cultivating and planting should be postponed because the soil is too wet.

Some areas of this soil, especially those adjacent to or near the Missouri River support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suitable as a site for septic tank absorption fields or buildings because of the flooding and the wetness. A suitable alternative is needed. Sewage lagoons should be constructed on fill material that raises the bottom of the lagoon a sufficient height above the seasonal high water table. Also, they should be diked, so that they are protected from flooding. Lining or sealing the lagoon helps to prevent seepage.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIw-2, dryland and irrigated; windbreak suitability group 2S.

On—Onawa silty clay, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom land in the valley of the Missouri River. It is occasionally flooded. It formed in clayey and silty alluvium. Areas range from 40 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, calcareous, firm silty clay about 8 inches thick. The upper part of the underlying material is olive gray, mottled, calcareous silty clay. The next part is stratified grayish brown and dark grayish brown, mottled, calcareous silt loam and very fine sandy loam. The lower part to a depth of more than 60 inches is dark grayish brown, calcareous fine sand. In a few areas the surface layer is silt loam or silty clay loam. In places the underlying material is highly stratified with alternating layers of silty clay.

Included with this soil in mapping are areas of Albaton and Haynie soils. The poorly drained Albaton soils are in the slightly lower landscape positions. Haynie soils are silty throughout. They are on ridges. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the upper part of the Onawa soil and moderately rapid in the lower part. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 2 feet in wet years to 4 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate.

The shrink-swell potential is high in the upper part of the soil and low in the lower part. Tilth is poor, and the soil can be worked only within a narrow range in moisture content. Working the soil is difficult because it is sticky and tough when wet and cracks open and becomes very hard when it dries.

Most of the acreage is cropland. Some of the areas closer to the river support native trees or pasture plants. Timber logs are harvested from some of these areas. Otherwise, the areas provide excellent wildlife habitat.

If used for dryland farming, this soil is suited to soybeans, corn, grain sorghum, and grasses. The flooding is a hazard, and the wetness is the principal limitation. The flooding is controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plains also can help to control the flooding. Grain sorghum and soybeans are better suited than corn because they can be planted later in the spring. Also, corn may be adversely affected by hot, dry periods in the summer, when the plants are in critical stages of development. The soil holds moisture tightly and does not release it fast enough to maintain the corn plants. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Filling low areas and establishing a general land grade help to drain surface water. In places surface ditches are feasible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Returning crop residue to the soil increases the content of organic matter and improves soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, grain sorghum, and close-sown crops, such as alfalfa, grasses, and small grain. The wetness, which is caused mainly by the seasonal high water table, is the principal limitation. It commonly delays tillage in the spring. This soil is flooded on an average of about once every 3 to 10 years, but crop losses are normally only slight. Both sprinkler and gravity systems are suitable. If a gravity system is used, some land leveling generally is needed to achieve an even distribution of water and uniform drainage. Conservation tillage practices that leave most of the crop residue on the surface help to control soil blowing and improve tilth.

This soil is suited to pasture, generally bromegrass or a mixture of bromegrass and alfalfa or orchardgrass and alfalfa. A cover of these plants is very effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the pasture in good condition. Timely mowing helps to control competition from weeds.

This soil generally is a good site for the trees and shrubs grown as windbreaks if the species selected for planting are those that can withstand the occasional wetness. Establishing seedlings is difficult in wet years. Timely cultivation and weed control are management concerns. Weeds and grasses can be controlled by cultivating with conventional equipment before and after the trees or shrubs are planted and by applying carefully selected herbicides. In some years cultivating and planting should be postponed because the soil is too wet.

Some areas of this soil, especially those adjacent to or near the Missouri River support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suitable as a site for septic tank absorption fields or buildings because of the flooding and the wetness. A suitable alternative site is needed. Sewage lagoons should be constructed on fill material that raises the bottom of the lagoon a sufficient height above the seasonal high water table. Also, they should be diked, so that they are protected from flooding. Lining or sealing the lagoon helps to prevent seepage.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIw-1, dryland and irrigated; windbreak suitability group 2S.

PaC—Pawnee clay loam, 3 to 9 percent slopes. This deep, gently sloping and strongly sloping, moderately well drained soil is on side slopes, foot slopes, and narrow divides in the uplands. It formed in glacial till. Areas range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray, friable clay loam about 11 inches thick. The subsoil is about 37 inches thick. The upper part is very dark grayish brown, friable clay loam, and the lower part is dark yellowish brown, mottled, very firm clay. The underlying material to a depth of more than 60 inches is light brownish gray, mottled clay loam. A few small areas are on the concave parts of the landscape. In some areas the dark surface layer is thinner.

Included with this soil in mapping are small areas of Burchard, Judson, Morrill, and Shelby soils, generally on the lower parts of the landscape. Burchard, Morrill, and Shelby soils contain less clay in the subsoil than the Pawnee soil. Judson soils contain less clay throughout than the Pawnee soil and are dark to a depth of more than 24 inches. Included soils make up 2 to 15 percent of the unit.

Permeability is slow in the Pawnee soil. Available water capacity is moderate. Runoff is rapid. The depth to a perched seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is poor because of the high content of clay.

About 70 percent of the acreage is pasture or range. The rest is cultivated.

If used for dryland farming, this soil generally is poorly suited to most kinds of cultivated crops because of the claypan subsoil and the moderate available water capacity. It is best suited to cool-season small grain, including oats and wheat, or to drought-resistant crops, including grain sorghum and forage sorghum. Drought and erosion are the major hazards. Other management concerns are the organic matter content, the fertility level, and workability. If row crops are grown year after year., controlling erosion is difficult unless a combination of special conservation practices is used. A conservation tillage system that returns most of the crop residue to the soil increases the rate of water intake, conserves moisture, adds organic matter, and helps to prevent excessive erosion. Terracing and farming on the contour also help to prevent excessive erosion. Grassed waterways can carry excess water from fields without eroding drainageways. If these conservation measures are not used, the soil can be protected by growing clean-cultivated row crops only on a limited basis and by favoring close-growing small grain, legumes, or legume-grass mixtures as much as possible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Timely tillage helps to prevent compaction and preserves soil structure. Applying barnyard manure and commercial fertilizers, such as phosphate, nitrogen, and lime, improves fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

This soil is a poor site for the trees and shrubs grown as farmstead or feedlot windbreaks and as plantings that enhance recreation areas and wildlife habitat. It generally is not suited to field windbreaks. The survival and growth rates of adapted species are fair. The high content of clay, drought, and competition from weeds and grasses are management concerns. The soil should be prepared for planting when it is moist, but not when it is wet. The site can be prepared by tillage or by a combination of chemicals and tillage. Supplemental watering can provide the water needed during periods of insufficient moisture. Cultivating with conventional equipment and growing annual cover crops between the rows and applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Hand hoeing or rototilling is needed in some areas.

This soil generally is not suitable as a septic tank absorption field because of the slow permeability and the wetness. A suitable alternative site is needed. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Constructing the buildings on raised, well-compacted fill material helps to overcome the wetness caused by the high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIIe-2, dryland; windbreak suitability group 4C.

PbC2—Pawnee clay, 3 to 9 percent slopes, eroded. This deep, gently sloping and strongly sloping, moderately well drained soil is on side slopes and narrow ridgetops in the uplands. It formed in glacial till. Erosion has removed most of the surface layer. The rest

has been mixed with subsoil material by tillage. Rills and gullies form in cultivated areas during periods of heavy rainfall. Areas range from 5 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay about 5 inches thick. The subsoil is about 35 inches thick. The upper part is dark brown, firm clay, the next part is dark yellowish brown, mottled, very firm clay, and the lower part is light olive, mottled clay loam. The underlying material to a depth of more than 60 inches is light olive brown, mottled clay loam. In a few small areas on the concave parts of the landscape, the soil is not eroded. In some small areas the slope is slightly more than 9 percent.

Included with this soil in mapping are small areas of Burchard, Judson, Morrill, and Shelby soils, generally on the lower parts of the landscape. Burchard, Morrill, and Shelby soils contain less clay in the subsoil than the Pawnee soil. Judson soils contain less clay throughout than the Pawnee soil and are dark to a depth of more than 24 inches. Included soils make up 2 to 15 percent of the unit.

Permeability is slow in the Pawnee soil. Available water capacity is moderate. Runoff is rapid. The depth to a perched seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is poor because of the high content of clay.

About 50 percent of the acreage is cultivated. The rest is pasture or range.

If used for dryland farming, this soil generally is poorly suited to most kinds of cultivated crops because of the hazard of further erosion, the claypan subsoil, and the moderate available water capacity. It is best suited to cool-season small grain, including oats and wheat, or to drought-resistant crops, including grain sorghum and forage sorghum. Drought and erosion are the major hazards. Other management concerns are the organic matter content, the fertility level, and workability. If row crops are grown year after year, controlling erosion is difficult unless a combination of special conservation practices is used. A conservation tillage system that returns most of the crop residue to the soil increases the rate of water intake, conserves moisture, adds organic matter, and helps to prevent excessive erosion. Terracing and farming on the contour also help to prevent excessive erosion. Grassed waterways can carry excess water from fields without eroding drainageways. If these conservation measures are not used, the soil can be protected by growing clean-cultivated row crops only on a limited basis and by favoring close-growing small grain, legumes, or legume-grass mixtures as much as possible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Timely tillage helps to prevent compaction and preserves soil structure. Applying barnyard manure and commercial fertilizers, such as phosphate, nitrogen, and lime, improves fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

This soil is a poor site for the trees and shrubs grown as farmstead or feedlot windbreaks and as plantings that enhance recreation areas and wildlife habitat. It generally is not suited to field windbreaks. The survival and growth rates of adapted species are fair. The high content of clay, drought, and competition from weeds and grasses are management concerns. The soil should be prepared for planting when it is moist, but not when it is wet. The site can be prepared by tillage or by a combination of chemicals and tillage. Supplemental watering can provide the water needed during periods of insufficient moisture. Cultivating with conventional equipment and growing annual cover crops between the rows and applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Hand hoeing or rototilling is needed in some areas.

This soil generally is not suitable as a septic tank absorption field because of the slow permeability and the wetness. A suitable alternative site is needed. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Strengthening the foundation of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Constructing the buildings on raised, well-compacted fill material helps to overcome the wetness caused by the high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better

performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IVe-4, dryland; windbreak suitability group 4C.

Pe—Percival-Albaton silty clays, 0 to 2 percent slopes. These deep, nearly level soils are in swales on bottom land in the valley of the Missouri River. They are occasionally flooded. The poorly drained Albaton soil is slightly lower on the landscape than the somewhat poorly drained Percival soil. The Albaton soil formed in clayey alluvium, and the Percival soil formed in clayey alluvium over sandy alluvium. Areas range from 5 to 100 acres in size. They are 75 to 85 percent Percival soil and 15 to 25 percent Albaton soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Percival soil has a surface layer of very dark gray, friable silty clay about 6 inches thick. The upper part of the underlying material is dark grayish brown and very dark grayish brown silty clay. The next part is olive gray, mottled silty clay. The lower part to a depth of more than 60 inches is grayish brown, mottled fine sand. In some areas the clayey layer is only 12 to 14 inches thick. In other areas thin strata of silt loam are in the underlying material.

Typically, the Albaton soil has a surface layer of very dark gray, firm silty clay about 6 inches thick. The underlying material to a depth of more than 60 inches is mottled silty clay. The upper part is mixed very dark grayish brown and grayish brown, and the lower part is olive gray. In some areas thin strata of silt loam are in the underlying material.

Included with these soils in mapping are small areas of the excessively drained, sandy Sarpy soils. These included soils are in the higher areas. They make up 2 to 5 percent of the unit.

Permeability is slow in the upper part of the Percival soil and rapid in the lower part. It is very slow in the Albaton soil. Available water capacity is low in the Percival soil and moderate in the Albaton soil. Runoff is slow on both soils. The depth to the seasonal high water table in the Percival soil ranges from 2 feet in wet years to about 4 feet in dry years. The depth to the seasonal high water table in the Albaton soil ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low in both soils. Organic matter content is moderate. The shrink-swell potential is high in the upper part of the Percival soil and low in the lower part. It is high throughout the Albaton soil. Tilth is poor in both soils. The soils can be worked only within a narrow range in moisture content. Working the soils is difficult because they are sticky and tough when wet and crack open and become very hard when they dry.

About 60 percent of the acreage is cropland, and 40 percent is pasture. A few of the areas closer to the river support native trees. Timber logs are harvested from some of these areas. Otherwise, the areas provide excellent wildlife habitat.

If used for dryland farming, these soils are suited to corn, grain sorghum, and small grain and to grasses and legumes for hay and pasture. The wetness is the principal limitation. Because the soils warm up slowly in the spring, tillage is delayed. Conservation tillage practices that keep most of the crop residue on the surface conserve moisture and build up the supply of organic matter. Flooding can be controlled by establishing dikes and levees on the higher lying adjacent soils. Drainage ditches help to remove water early in spring and thus allow the soils to be tilled sooner. Many areas are tilled in the fall so that freezing and thawing during the winter can improve tilth.

If irrigated, these soils are suited to corn, grain sorghum, and close-sown crops, such as alfalfa, grasses, and small grain. The wetness, which is caused mainly by the seasonal high water table, is the principal limitation. It commonly delays tillage in the spring. The soils are flooded on an average of about once every 3 to 10 years, but crop losses normally are only slight. Both sprinkler and gravity systems are suited. If a gravity system is used, the runs should be short because the underlying material in the Percival soil is sandy. Also, some land leveling generally is needed to achieve an even distribution of water and uniform drainage. Conservation tillage practices that leave most of the crop residue on the surface help to control soil blowing and improve tilth.

These soils are suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

These soils are suited to some of the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival rate of adapted species is good. Only the trees and shrubs that can withstand the high water table and the occasional flooding should be selected for planting. Cultivating with a disk between the rows and hand hoeing and rototilling in the rows help to control weeds and grasses. Supplemental watering may be needed during periods when rainfall is insufficient.

Some areas of these soils, especially those adjacent to or near the Missouri River, support stands of native

trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

These soils are not suitable as sites for sanitary facilities or buildings because of the flooding. An alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the Albaton soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling of the Albaton soil. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness.

The capability unit is IIIw-1, dryland and irrigated. The Percival soil is in windbreak suitability group 2S, and the Albaton soil is in windbreak suitability group 2W.

Pt—Pits, quarries. This miscellaneous area consists of open excavations from which soil and the underlying limestone have been removed. It includes the overburden of soil and limestone, which generally is stockpiled adjacent to the excavations. The limestone is used for agricultural lime, construction, and road surfacing. Deep excavations are filled with water in places. Slopes are level in some areas but range to vertical on the walls. Areas range from 5 to 150 acres in size.

Typically, the material in this area is a mixture of silty clay loam, silt loam, clay loam, and limestone, sandstone, and shale rock of various sizes. The stockpiled soil material is a mixture of the original soils that have been disturbed by excavation.

Included in mapping are areas where the limestone is processed for various uses and areas where the limestone is no longer mined.

Most of the acreage is used for the commercial production of limestone. The areas no longer mined are used as wildlife habitat. Unless it is reclaimed, this area can be used only for a limited number of purposes. It is unsuited to agricultural uses, building site development, and sanitary facilities. Grading and land filling generally are needed if vegetation is to be reestablished.

The capability unit is VIIIs-8, dryland; windbreak suitability group 10.

SaB—Sarpy loamy fine sand, 0 to 3 percent slopes. This deep, nearly level and very gently sloping, excessively drained soil is on bottom land, generally adjacent to or near the Missouri River. It is occasionally flooded. It formed in sandy alluvium. Areas generally are long and narrow and range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown, calcareous, loose loamy fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is calcareous fine sand. It is dark grayish brown in the upper part and grayish brown in the lower part. In some areas the lower part of the underlying material is stratified with very fine sandy loam. In other areas the surface layer is silty clay loam, silt loam, or very fine sandy loam.

Included with this soil in mapping are small areas of Haynie soils. These soils are siltier than the Sarpy soil. Also, they are slightly lower on the landscape. Also included are poorly drained soils along low-lying former river channels. These soils have a thin silty or clayey surface layer and are underlain by sand. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Sarpy soil. Available water capacity is moderate. Runoff is slow. The water intake rate for irrigation is very high. Organic matter content is low. The soil may be deficient in nitrogen and phosphorus. Tilth is poor in this loose, sandy soil.

About half of the acreage is cropland, and half supports native trees, underbrush, and grasses. The extent of farming varies considerably from area to area. Timber logs are harvested from some areas, especially those closer to the river. If they are not used for timber, these areas can provide excellent wildlife habitat.

If used for dryland farming, this soil is poorly suited to cultivated crops because of droughtiness, low fertility, and the occasional flooding. The occasional flooding can be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also help to control flooding. Conservation tillage practices that leave most of the crop residue on the surface conserve moisture, help to control soil blowing, and build up the supply of organic matter. Applying fertilizer improves fertility. Close-sown crops are better suited than row crops because their growing period is mainly in spring, when the amount of rainfall is greatest.

If irrigated, this soil is suited to corn, grain sorghum, alfalfa, and small grain. Soil blowing and the moderate available water capacity are the main concerns of management. Because of a rapid infiltration rate, frequent applications of a small amount of water are needed. As a result, a sprinkler irrigation system is the only practical system. Because of the hummocky topography and the rapid infiltration rate, ditch systems are impractical. Planting close-growing crops and applying conservation tillage systems help to control soil blowing and reduce the amount of water lost through evaporation.

This soil is a good site for the trees and shrubs grown as windbreaks. The survival and growth rates of adapted species are fair. Soil blowing and competition for moisture are concerns of management. Soil blowing can be controlled by maintaining strips of sod or annual cover crops between the tree rows. Cultivation generally should be restricted to the tree rows. Irrigation can

provide supplemental moisture during periods of low rainfall.

This soil is well suited to wildlife habitat. The areas that support native vegetation provide food and cover for many species of woodland wildlife. Preserving this vegetation helps to maintain the wildlife population.

Some areas of this soil, especially those adjacent to or near the Missouri River, support stands of native trees. Selectively cutting the larger trees for firewood or lumber provides more sunlight, space, and moisture for the smaller trees, which can then grow to maturity.

This soil is not suitable as a site for septic tank absorption fields or buildings because of the flooding. A suitable alternative is needed. Sewage lagoons should be diked, so that they are protected from flooding. Lining or sealing the lagoon helps to prevent seepage. Constructing local roads and streets on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding.

The capability units are IVs-7, dryland, and IIIs-11, irrigated; windbreak suitability group 7.

SbB—Sarpy-Haynie complex, 0 to 3 percent slopes. These deep, nearly level and very gently sloping soils are on bottom land in the valley of the Missouri River. They are frequently flooded. The excessively drained Sarpy soil commonly is very gently sloping or undulating and is on ridges. The moderately well drained Haynie soil is in the more nearly level areas. Both soils formed in alluvium. Areas are long and narrow and generally are adjacent to the Missouri River. They range from 10 to 50 acres in size. They are 50 to 60 percent Sarpy soil and 40 to 50 percent Haynie soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Sarpy soil has a surface layer of very dark grayish brown, loose loamy sand about 6 inches thick. The upper part of the underlying material is grayish brown fine sand. The lower part to a depth of more than 60 inches is grayish brown loamy fine sand stratified with silt loam and very fine sandy loam.

Typically, the Haynie soil has a surface layer of very dark grayish brown, very friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches is dark grayish brown, mottled, stratified, calcareous silt loam, very fine sandy loam, and loamy very fine sand. Old river channels are in some areas. In other areas underlying material is silt loam.

Included with these soils in mapping are small areas of Grable soils on the slightly higher parts of the landscape. These included soils are less silty than the Haynie soil and less sandy than the Sarpy soil. They make up 5 to 15 percent of the unit.

Permeability is rapid in the Sarpy soil and moderate in the Haynie soil. Available water capacity is moderate in the Sarpy soil and high in the Haynie soil. Runoff is slow on both soils. Organic matter content is low in the Sarpy soil and moderate in the Haynie soil. Tilth is poor in both soils.

Most of the acreage supports native trees, underbrush, and grasses. A few areas have been cleared of trees and are farmed. Timber logs are harvested from some areas. If they are not used for timber, these areas provide excellent wildlife habitat.

If used for dryland farming, these soils generally are suited to grain sorghum, corn, soybeans, and wheat. The flooding is a hazard. Soil blowing also is a hazard. The flooding can be controlled by dikes, diversions, and flood-control structures. Conservation tillage systems that leave crop residue on the surface help to control soil blowing and conserve moisture. Applying fertilizer helps to maintain fertility.

These soils are well suited to wildlife habitat. Areas that still support the native vegetation provide food and cover for many species of woodland wildlife. Preserving the existing vegetation helps to maintain the wildlife population.

These soils are suited to grasses. They can be used as hayland. The introduced grasses on these soils are smooth brome, orchardgrass, and reed canarygrass. The native grasses are big bluestem, indiangrass, and switchgrass. For quality hay, the grasses should be cut before they become tough and unpalatable.

These soils are good sites for the trees and shrubs grown as windbreaks and as plantings that enhance wildlife habitat and recreation areas. The survival and growth rates of adapted species are good. A lack of sufficient moisture, competition from weedy vegetation, and soil blowing are the principal management concerns. If available, irrigation water can be applied during periods of low rainfall. The weeds and grasses that compete for soil moisture can be controlled by cultivation, which generally should be restricted to the tree rows. Hand hoeing, rototilling, or applying appropriate herbicides in the rows also helps to control the weeds and grasses. Leaving a cover of plant residue between the rows helps to prevent excessive soil blowing. The species that are adapted to an excessive amount of calcium carbonates should be selected for planting.

These soils are not suitable as sites for sanitary facilities or buildings because of the flooding. A suitable alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the Haynie soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and

establishing adequate side ditches help to provide the needed surface drainage.

The capability unit IVs-7, dryland. The Sarpy soil is in windbreak suitability group 7, and the Haynie soil is in windbreak suitability group 1L.

Sh—Sharpsburg silty clay loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on high divides in the uplands. It formed in loess. Areas are circular or oblong and range from 10 to more than 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsurface layer is friable silty clay loam about 14 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown. The subsoil to a depth of more than 60 inches is friable silty clay loam. The upper part is dark brown, and the lower part is yellowish brown. In some areas the subsoil is mottled silty clay.

Permeability is moderately slow. Available water capacity is high. Runoff generally is medium. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate. The soil dries readily after rains and can be easily worked throughout a fairly wide range in moisture content.

Nearly all of the acreage is cropland. If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. If properly managed, it can be cultivated intensively without the risk of damage. Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. The amount of available soil moisture helps to determine the proper plant population. Conservation tillage practices, such as disking or chiseling, that leave all or part of the crop residue on the surface help to control erosion, increase the rate of water intake, and help to maintain the organic matter content. Working the soil when it is too wet can cause compaction. Timely tillage helps to prevent compaction and preserves soil structure.

This soil is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival and growth rates of adapted species are good. Competition from weeds and grasses is the main management concern. It can be controlled by cultivating between the tree rows with conventional equipment, by growing annual cover crops between the rows, and by carefully applying appropriate herbicides in the rows. Areas in the rows or near small trees can be hoed by hand or rototilled.

The moderately slow permeability is a limitation if this soil is used as a septic tank absorption field. This generally can be overcome, however, by increasing the size of the absorption field. Seepage is a limitation if the soil is used as a site for sewage lagoons. It can be controlled, however, by lining or sealing the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are I-1, dryland, and I-3, irrigated; windbreak suitability group 3.

ShC—Sharpsburg silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on high ridgetops and the upper side slopes in the uplands. It formed in loess. Areas generally are long and narrow and range from 10 to about 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is dark brown, firm silty clay loam about 31 inches thick. It is mottled in the lower part. The underlying material to a depth of more than 60 inches is brown, mottled silty clay loam. In some areas the surface layer is thinner and lighter colored. In other areas the subsoil contains slightly more clay and is mottled.

Included with this soil in mapping are small areas of Marshall soils. These soils are less clayey than the Sharpsburg soil. They are in positions on the landscape similar to those of the Sharpsburg soil. They make up 5 to 10 percent of the unit.

Permeability is moderately slow in the Sharpsburg soil. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

Most of the acreage is cropland. A few small areas are pasture.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but measures that control weeds, insects, and plant diseases are needed. Erosion is a hazard. It can be controlled, however, by conservation tillage and contour farming (fig. 10). Terraces help to protect the soil from concentrated runoff. Returning crop residue to the soil increases the rate of water intake and helps to maintain the content of organic matter. Tilling the soil at the right moisture content helps to prevent compaction and preserves soil

structure. Applying fertilizer and including growing legumes in the cropping sequence help to maintain fertility. Growing legumes also helps to maintain soil structure and porosity.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixtue of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is very effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to keep the pasture in good condition. Timely mowing helps to control competition from weeds.

This soil is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival and growth rates of adapted species are good. Competition from weeds and grasses is the main management concern. It can be controlled by cultivating between the tree rows with conventional equipment, by growing annual cover crops between the rows, and by carefully applying appropriate herbicides in the rows. Areas in the rows or near small trees can be hoed by hand or rototilled.

The moderately slow permeability is a limitation if this soil is used as a septic tank absorption field. This limitation generally can be overcome, however, by increasing the size of the absorption field. On sites for

Figure 10.—Contour farming in an area of Sharpsburg silty clay loam, 2 to 5 percent slopes, used for corn and wheat.

sewage lagoons, grading is needed to modify the slope and shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIe-1, dryland, and IIIe-3, irrigated; windbreak suitability group 3.

ShC2—Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, moderately well drained soil is on narrow ridgetops and the upper side slopes in the uplands. It formed in loess. Erosion has not been uniform on this soil. In most areas, however, the surface layer is lighter colored than that in the uneroded Sharpsburg soils. Most of the original surface layer has been removed by erosion. The rest has been mixed with subsoil material by tillage. Rills are common after heavy rains. Areas generally are long and narrow and range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is silty clay loam about 37 inches thick. The upper part is mixed very dark grayish brown and dark brown and is friable, the next part is dark brown and firm, and the lower part is dark brown, mottled, and friable. The underlying material to a depth of more than 60 inches is brown, mottled silty clay loam. In some small areas the surface layer is thicker and darker. In places the subsoil is mottled.

Included with this soil in mapping are small areas of Marshall and Gymer soils. Marshall soils contain less clay in the subsoil than the Sharpsburg soil. Gymer soils have a reddish brown subsoil. Included soils make up 5 to 10 percent of the unit.

Permeability is moderately slow in the Sharpsburg soil. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate. Tilth is good.

Most of the acreage is cultivated. Some small areas are pasture.

If used for dryland farming, this soil is suited to corn, grain sorghum, small grain, and alfalfa. Further erosion is a hazard. It can be controlled, however, by grassed waterways, conservation tillage systems, contour farming, and terraces. Conservation tillage practices, such as disking or chiseling, that return crop residue to the soil not only help to control erosion but also conserve moisture and add organic matter. Applications of commercial fertilizer improve the fertility of this light-colored, eroded soil.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is a good site for the trees and shrubs grown as windbreaks. Erosion is a hazard. Also, competition for moisture from grasses and weeds limits the establishment of seedlings. Planting on the contour and growing cover crops between the rows help to control erosion. Carefully applying appropriate herbicides and cultivating between the rows can help to control undesirable grasses and weeds, which can choke out seedlings. The windbreak should be protected from livestock.

The moderately slow permeability is a limitation if this soil is used as a septic tank absorption field. This limitation generally can be overcome, however, by increasing the size of the absorption field. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIe-8, dryland, and IIIe-3, irrigated; windbreak suitability group 3.

ShD2—Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded. This deep, moderately well drained, strongly sloping soil is on upland side slopes bordering intermittent drainageways. It formed in loess. Erosion has removed most of the original surface layer. The rest is being mixed with subsoil material by tillage. Rills and gullies form during periods of heavy rainfall. Areas generally are dissected by shallow drainageways and are long and narrow. They range from 20 to 200 acres in size.

Figure 11.—Conservation tillage in a stripcropped area of soybeans and wheat on Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded.

Typically, the surface layer is very dark gray, friable silty clay loam about 8 inches thick. The subsoil is firm silty clay loam about 24 inches thick. The upper part is dark grayish brown, and the lower part is dark brown. The underlying material to a depth of more than 60 inches is grayish brown silty clay loam. In some areas the surface layer is thicker.

Included with this soil in mapping are small areas of Colo, Judson, Marshall, and Nodaway soils. Colo soils are somewhat poorly drained and are on bottom land. Judson and Marshall soils contain less clay in the subsoil than the Sharpsburg soil. Judson soils are on foot slopes. Marshall soils are in positions on the landscape similar to those of the Sharpsburg soil. Nodaway soils are stratified and are on bottom land. Included soils make up 3 to 10 percent of the unit.

Permeability is moderately slow in the Sharpsburg soil. Available water capacity is high. The soil readily releases moisture to plants. Runoff is rapid. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate.

Most of the acreage of this soil is farmed. A few small areas are in pasture.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, and grasses and legumes. Further erosion is the main hazard, and conservation of water and improvement of fertility are important management concerns. Conservation tillage practices, such as disking or chiseling, that leave crop residue on the surface help to control erosion and conserve moisture (fig. 11). Terraces conserve surface water and help to prevent excessive soil loss (fig. 12).

Contour farming and grassed waterways also help to control erosion. Applying commercial fertilizer and including legumes in the cropping sequence improve fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival and growth rates of adapted species are good. Erosion and excessive runoff are the main hazards. They can be controlled by planting on the contour and terracing. Cultivating between the rows with conventional equipment, growing annual cover crops between the rows, and carefully applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Areas in the rows or near small trees can be hoed by hand or rototilled. Tree growth may be somewhat slower on the steepest slopes.

The moderately slow permeability and the slope are limitations if this soil is used as a septic tank absorption field. Enlarging the absorption field helps to overcome the moderately slow permeability. Land shaping and installing the absorption field on the contour help to ensure better performance. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Sealing or lining the lagoon helps to prevent seepage. Buildings should be designed so that they conform to the natural slope of the land, or the soil should be graded to an acceptable gradient. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a good surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIIe-8, dryland, and IVe-3, irrigated; windbreak suitability group 3.

SkD—Shelby clay loam, 5 to 11 percent slopes. This deep, strongly sloping, well drained soil is on uneven side slopes and the upper parts of foot slopes in the loess-capped glacial uplands. It formed in glacial till. Areas are long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is black, friable clay loam about 9 inches thick. The subsurface layer is very dark gray, friable clay loam about 8 inches thick. The subsoil is firm clay loam about 25 inches thick. The upper part is dark brown, and the lower part is grayish brown. The underlying material to a depth of more than 60 inches is grayish brown clay loam. Sand grains and pebbles are throughout this soil. In some areas the surface layer and the upper part of the subsoil contain less clay. In other areas the soil has a thinner surface layer and is as shallow as 30 inches to lime.

Included with this soil in mapping are small areas of Judson, Mayberry, Morrill, Nodaway, and Pawnee soils. Judson soils are lower on the landscape than the Shelby soil. Also, their surface soil is thicker. Mayberry and Morrill soils formed in reddish material. Morrill soils are in positions on the landscape similar to those of the Shelby soil. Mayberry and Pawnee soils have more clay in the subsoil than the Shelby soil. They are on the higher parts of the landscape. Nodaway soils are on bottom land and are stratified throughout. Included soils make up about 2 to 15 percent of the unit.

Permeability is moderately slow in the Shelby soil. Available water capacity is high. Runoff is medium. The water intake rate for irrigation is low. Organic matter content is moderate. The shrink-swell potential also is moderate. The soil generally has some rocks and pebbles on the surface. Tilth is fair.

About half of the acreage is cropland. The rest is pasture or range.

If used for dryland farming, this soil is suited to soybeans, grain sorghum, wheat, and grasses and legumes. Erosion is the main hazard, and conservation of water is an important management concern. Conservation tillage practices, such as disking or chiseling, that leave crop residue on the surface help to control erosion and conserve moisture. Contour farming and grassed waterways also help to control erosion. Applying commercial fertilizer and including legumes in the cropping sequence improve fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem,

porcupinegrass, sideoats grama, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

This soil is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival and growth rates of adapted species are good. Erosion and excessive runoff are the main hazards. They can be controlled by planting on the contour and terracing. Cultivating between the rows with conventional equipment, growing annual cover crops between the rows, and carefully applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Areas in the rows or near small trees can be hoed by hand or rototilled. Tree growth may be somewhat slower on the steepest slopes.

The moderately slow permeability is a limitation if this soil is used as septic tank absorption field. It can be overcome, however, by enlarging the absorption field. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Buildings should be designed so that they conform to the natural slope of the land, or the soil should be graded to an acceptable gradient. Strengthening the foundations and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

The capability unit is IIIe-1, dryland; windbreak suitability group 3.

Figure 12.—Terraces and contour farming in an area of Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded.

SkF—Shelby clay loam, 15 to 30 percent slopes. This deep, steep, well drained soil is on side slopes in the uplands. It is commonly adjacent to the major drainageways. It formed in glacial till. Areas are long and narrow and range from 5 to about 50 acres in size.

Typically, the surface layer is black, friable clay loam about 9 inches thick. The subsurface layer is very dark gray, friable clay loam about 7 inches thick. The subsoil is clay loam about 34 inches thick. The upper part is dark brown and friable, and the lower part is yellowish brown, mottled, and firm. The underlying material to a depth of more than 60 inches is dark yellowish brown, mottled, firm clay loam. In some areas the surface layer is silt loam or silty clay loam. In other areas the depth to lime is about 20 inches.

Included with this soil in mapping are small areas of Mayberry, Morrill, Nodaway, and Pawnee soils and small areas of stone-free soils that formed in loess. The stone-free soils are in positions on the landscape similar to those of the Shelby soil. Mayberry and Morrill soils formed in reddish material. Nodaway soils are on bottom land and are stratified throughout. Pawnee soils have more clay in the subsoil than the Shelby soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately slow in the Shelby soil. Available water capacity is high. Runoff is rapid. Organic matter is moderate. The shrink-swell potential also is moderate.

Most areas support native grasses or trees. These areas are used mainly as range. A few areas along the outer edges of the unit are cultivated or formerly were cultivated.

Because of the steep slope, this soil is unsuited to cultivation. It is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

If this soil is used as a site for native woodlots, livestock should be fenced from the stands and the less desirable trees should be removed. Also, measures that improve the stands are needed. Small areas can be left undisturbed and used as habitat for wildlife.

These soils generally are unsuited to windbreaks. The survival and growth rates of adapted species are poor. The steep slope generally restricts the use of planting machinery. In some areas, however, slopes are smooth enough for the use of machines. In these areas the seedlings can be planted on the contour in a shallow furrow 18 to 24 inches wide. They can be hand planted in areas where machinery cannot be used.

This soil is well suited to wildlife habitat. It supports a wide variety of plants that provide cover and food for range and woodland wildlife. The main threat to the wildlife population is the destruction of habitat through indiscriminate burning and other practices.

This soil is not suitable as a site for sanitary facilities or buildings because of the excessive slope. A suitable alternative site is needed. Local roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Cutting and filling generally are needed to provide a suitable grade.

The capability unit is VIe-1, dryland; windbreak suitability group 10.

SvF—Sogn-Kipson complex, 6 to 30 percent slopes. These shallow or very shallow, strongly sloping to steep, somewhat excessively drained soils are on uplands. The Sogn soil is on ridgetops and the upper side slopes. The Kipson soil is on the more concave parts of the landscape and the lower side slopes. The soils formed in material weathered from limestone and shale. Limestone commonly crops out. Areas are irregularly shaped and are longer than they are wide. They range from 20 to 150 acres in size. They are about 65 to 75 percent Sogn soil and 20 to 25 percent Kipson soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Sogn soil has a surface layer of very dark gray, friable loam about 8 inches thick (fig. 13). The content of limestone fragments in this layer is 10 to 15 percent. White, level-bedded, indurated limestone bedrock is at a depth of about 8 inches. In some areas the depth to limestone bedrock is more than 20 inches.

Typically, the Kipson soil has a surface layer of very dark grayish brown, friable silty clay loam about 10 inches thick. The content of shale and limestone fragments in this layer is 10 to 15 percent. Grayish brown, bedded shale bedrock is at a depth of about 10 inches. In some areas the depth to bedded shale bedrock is more than 20 inches.

Included with these soils in mapping are small areas of Benfield, Sharpsburg, and Wymore soils on the lower slopes. Benfield soils are moderately deep. Sharpsburg and Wymore soils are deep and formed in loess. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Sogn and Kipson soils. Available water capacity is very low. Runoff is rapid. Organic matter content is moderate. The soils may be deficient in phosphorus.

Nearly all of the acreage is range. A few areas support native trees. Limestone pits are in many areas. Vegetation gradually becomes established in areas

Figure 13.—Profile of the Sogn soil in the Sogn-Kipson complex, 6 to 30 percent slopes. This soil is very shallow over limestone bedrock. The scale is marked in feet.

where the pits are no longer mined. These soils generally are not suited to farming because they are too steep and are shallow or very shallow over bedrock.

These soils are suited to range. A cover of range plants is effective in controlling erosion. The natural plant community is dominated by big bluestem, little bluestem, indiangrass, sideoats grama, and switchgrass. When the plants are overgrazed, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, blue grama, and hairy grama increase. If overgrazing continues for many years, the less desirable woody plants, including bur oak, sumac, buckbrush, snowberry, and dogwood, increase in abundance. Brush management may be needed to control these plants.

These soils generally are poor sites for the trees grown as windbreaks. Cottonwoods, willows, and cedars are best suited as either individual or scattered plantings. Special management measures, such as hand planting, scalp planting, or special site preparation, are needed.

These soils generally are unsuitable as sites for sanitary facilities because they are very shallow or shallow over bedrock and are too steep. A suitable alternative site is needed. Buildings should be designed so that they conform to the natural slope of the land. The hard bedrock should be excavated if the soils are used as sites for dwellings with basements or for buildings that have deep foundations. Cutting and filling generally are needed to provide a suitable grade for local roads and streets. The hard limestone should be excavated or blasted.

The capability unit is VIs-4, dryland; windbreak suitability group 10.

Ud—Udorthents, silty. These very gently sloping to moderately steep soils are areas of overburden from nearby quarries. Areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the soil material is silty clay loam and silt loam mixed with stones of various sizes. The colors are mixed and are similar to those of the subsoil and underlying material in the original soils. In some areas the depth to the underlying buried soil is less than 60 inches.

Most of the acreage has been seeded to introduced grasses. These soils are suited to grasses and legumes for pasture. Smooth brome, orchardgrass, tall fescue, and reed canarygrass grow well. Including legumes in the grass mixture increases forage production. Fertilizer should be applied according to the results of soil tests. Proper stocking rates, rotation grazing, weed control, and timely mowing help to maintain the vigor of the grasses.

These soils are poorly suited to windbreaks. In some areas, however, selected species can be hand planted. Onsite investigation is needed to determine the suitability of the soils for engineering uses and the management requirements for those uses.

The capability unit is VIs-8, dryland; windbreak suitability group 10.

Wc—Wabash silty clay, 0 to 1 percent slopes. This deep, nearly level, very poorly drained soil is on bottom land. It is occasionally flooded. It formed in clayey

alluvium. Areas range from 20 to several hundred acres in size.

Typically, the surface layer is very dark gray, friable silty clay about 9 inches thick. The subsurface layer is very dark gray, firm silty clay about 9 inches thick. The subsoil extends to a depth of more than 60 inches. It is very dark gray, mottled, and very firm. It is clay in the upper part and silty clay in the lower part. In some areas the surface layer is silty clay loam or silt loam. In other areas the subsoil contains less clay.

Included with this soil in mapping are small areas of Zook soils. These soils are in positions on the landscape similar to those of the Wabash soil. They contain less clay than the Wabash soil. They make up 2 to 10 percent of the unit.

Permeability is very slow in the Wabash soil. Available water capacity is moderate. Runoff is very slow. The seasonal high water table is at a depth of 1 foot in wet years and at a depth of 2 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is very high. Tilth is poor, and the soil can be worked only within a narrow range in moisture content. Working the soil is difficult because it is sticky and tough when wet and cracks open and becomes very hard when it dries.

Most of the acreage is cropland. A few areas are pasture.

If used for dryland farming, this soil is suited to soybeans, corn, grain sorghum, and grasses. The occasional flooding is a hazard. The floodwater generally recedes within a few hours, however, and crops are seldom severely damaged. The flooding is controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. The wetness is the principal limitation. Grain sorghum or soybeans are better suited than corn because they can be planted later in the spring. During periods of inadequate rainfall, corn may be adversely affected by hot, dry periods in the summer, when the plants are in a critical stage of development. The soil holds moisture tightly and does not release it fast enough to maintain the corn plants. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Filling low areas and establishing a general land grade help to drain surface water. In places surface ditches are feasible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Returning crop residue to the soil increases the content or organic matter and improves soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, grain sorghum, soybeans, small grain, and grasses. A furrow or border irrigation system is suitable. The rate of water application should be adjusted to the very low water intake rate of the soil. Ponding can be controlled by land leveling, which results in smooth, level fields, and by diversions, which divert the runoff from the higher lying adjacent soils.

This soil is suited to introduced grasses for pasture, such as a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. Excessive wetness limits the choice of pasture grasses and legumes. Grazing when the water table is highest results in damage to the grass stand, a rough surface, and difficulty in mowing for hay. Because of the wetness, seeding the grass can be difficult. A drainage system of V-ditches or perforated tile reduces the wetness caused by the high water table. Proper stocking rates and rotation grazing help to keep the pasture in good condition. Applying nitrogen fertilizer increases plant growth and vigor. Timely mowing helps to control competition from weeds.

This soil generally is a good site for the trees and shrubs grown as windbreaks if the species selected for planting can withstand the occasional wetness. Establishing seedlings is difficult in wet years. Timely cultivation and weed control are management concerns. Weeds can be controlled by cultivating with conventional equipment before and after the trees or shrubs are planted and by applying appropriate herbicides. In some years cultivating and planting should be postponed because the soil is too wet.

This soil is not suitable as a septic tank absorption field because of the flooding, the wetness, and the very slow permeability. It is not suitable as a site for buildings because of the flooding, the wetness, and the very high shrink-swell potential. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness.

The capability unit is IIIw-1, dryland and irrigated; windbreak suitability group 2W.

Wd—Wabash silty clay, 0 to 1 percent slopes, depressional. This deep, nearly level, very poorly drained soil is on bottom land. It is frequently flooded and is ponded for extended periods when the amount of rainfall is high. The soil formed in clayey alluvium. Areas range from 10 to 100 acres in size.

Typically, the surface layer is black, friable silty clay about 11 inches thick. The subsurface layer is black, very firm silty clay about 7 inches thick. The subsoil is

very dark gray, mottled silty clay about 18 inches thick. The underlying material to a depth of more than 60 inches is dark gray, mottled very firm silty clay. In some small areas the subsoil is calcareous. In places the surface soil is stratified silt loam.

Permeability is very slow. Available water capacity is moderate. Runoff is very slow. The seasonal high water table is as much as 0.5 foot above the surface in wet years and is within a depth of 1.0 foot in dry years. Organic matter content is moderate. The shrink-swell potential is very high.

All of the acreage is range. Hay is harvested in some areas during the drier years. Some areas support scattered willows. Because of the excessive wetness, this soil is unsuited to cultivation and to the trees and shrubs grown as windbreaks.

This soil is suited to range and native hay. The natural plant community is mostly tall and mid grasses and grasslike plants dominated by prairie cordgrass, bluejoint reedgrass, northern reedgrass, and various sedges. Also, timothy, redtop, reed canarygrass, and clover are overseeded in some areas. When the plants are overgrazed or improperly harvested for hay, the site may be dominated by timothy, redtop, foxtail barley, clover, Kentucky bluegrass, sedges, and rushes. If the plants are grazed early in spring or are overgrazed, small mounds form, making grazing or harvesting for hay difficult.

This soil is not suitable as a septic tank absorption field because of the flooding, the ponding, and the very slow permeability or as a site for sewage lagoons because of the ponding and the flooding. It is not suitable as a site for buildings because of the flooding, the ponding, and the very high shrink-swell potential. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by ponding.

The capability unit is Vw-7, dryland; windbreak suitability group 10.

Wt—Wymore silty clay loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on upland divides. It formed in loess. Areas are irregularly shaped and range from 10 to 300 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 10 inches thick. The subsoil is about 32 inches thick. It is mottled. The upper part is very dark brown, firm silty clay, the next part is very dark grayish brown, firm silty clay, and the lower part is dark grayish brown, very firm silty clay loam. The underlying material to a depth of more than 60 inches is grayish brown, mottled silty clay loam. In some areas the surface layer is thicker. In small depressional areas the soil is more poorly drained.

Included with this soil in mapping are small areas of Judson soils. These soils contain less clay throughout than the Wymore soil. They are on foot slopes below the Wymore soil. They make up about 5 percent of the unit.

Permeability is slow in the Wymore soil. Available water capacity is high. Runoff is slow. The depth to a perched seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is fair. The soil is sticky when wet and hard when dry. It releases moisture slowly to plants.

Nearly all of the acreage is cropland. A few small areas near farmsteads support grasses or windbreaks.

If used for dryland farming, this soil is suited to grain sorghum, corn, wheat, soybeans, oats, alfalfa, clover, and grasses. Because of the high content of clay, cultivated crops may be adversely affected by hot, dry periods in the summer, when the plants are at the critical stage of development. The soil holds moisture tightly and does not release it fast enough to maintain the plants. Otherwise, it can be cultivated intensively without the risk of damage if conservation tillage systems are applied. The amount of available moisture helps to determine the proper plant population. Returning crop residue to the soil increases the rate of water intake and helps to maintain the organic matter content. Working the soil when it is too wet in the spring can cause compaction. Timely tillage helps to prevent compaction and preserves soil structure. Applying fertilizer according to the amount of soil moisture helps to maintain fertility. Including legumes in the cropping sequence helps to maintain fertility and porosity.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is a poor site for the trees and shrubs grown as farmstead or feedlot windbreaks and as plantings that enhance recreation areas and wildlife habitat. It generally is not suited to field windbreaks. The survival and growth rates of adapted species are fair. The high content of clay and competition from weeds and grasses are the

main management concerns. The soil should be prepared for planting when it is moist, but not when it is wet. The site can be prepared by tillage or by a combination of chemicals and tillage. Growing annual cover crops between the rows and applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Hand hoeing or rototilling is needed in some areas.

This soil generally is not suitable as a septic tank absorption field because of the slow permeability and the wetness. A suitable alternative site is needed. The soil is suitable as a site for sewage lagoons. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Constructing the buildings on raised, well-compacted fill material helps to overcome the wetness caused by the high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIs-2, dryland, and IIs-1, irrigated; windbreak suitability group 4L.

WtC—Wymore silty clay loam, 2 to 7 percent slopes. This deep, gently sloping, moderately well drained soil is on upland divides and foot slopes and on side slopes adjacent to upland drainageways. It formed in loess. Areas range from 5 to 300 acres in size.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsoil is about 32 inches thick. It is mottled. The upper part is very dark brown, firm silty clay loam, the next part is dark grayish brown, very firm silty clay, and the lower part is grayish brown, very firm silty clay. The underlying material to a depth of more than 60 inches is light brownish gray, mottled silty clay loam. In some places the surface layer is thinner. In other places the subsoil contains less clay and is not mottled.

Included with this soil in mapping are small areas of Colo, Judson, Mayberry, Nodaway, and Pawnee soils. Colo, Judson, and Nodaway soils contain less clay throughout than the Wymore soil. Colo and Nodaway soils are on bottom land. Judson soils are on foot slopes below the Wymore soil. Mayberry and Pawnee soils formed in glacial till and on the lower hillsides. Also included are some areas adjacent to drainageways where the soil is affected by salinity. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Wymore soil. Available water capacity is high. Runoff is medium. The depth to a perched seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is fair.

Most of the acreage is cropland. Some small areas support introduced grasses and are used as pasture. A few areas are used as range.

If used for dryland farming, this soil is suited to grain sorghum, wheat, corn, soybeans, oats, alfalfa, clover, and grasses. Erosion is a hazard. Also, cultivated crops may be adversely affected by hot, dry periods in the summer, when the plants are at the critical stage of development. The soil holds moisture tightly and does not release it fast enough to maintain the plants. Conservation tillage systems that return crop residue to the soil improve the capacity of the soil to absorb water, conserve moisture, and help to maintain the content of organic matter. Terraces, grassed waterways, and contour farming help to control erosion. Row crops can be grown more frequently in the cropping sequence if these measures are applied. If these measures are not applied, the soil can be protected by growing clean-cultivated row crops only on a limited basis and by including close-growing small grain, legumes, or legume-grass mixtures in the cropping sequence as much as possible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

This soil is a poor site for the trees and shrubs grown as farmstead or feedlot windbreaks and as plantings that enhance recreation areas and wildlife habitat. It generally is not suited to field windbreaks. The survival and growth rates of adapted species are fair. The high content of clay, drought, competition from weeds and grasses, excessive slope and runoff, and the formation of cracks, which results from shrinking and swelling, are management concerns. The trees should be planted when the soil is moist, but not when it is wet. Supplemental watering can provide the water needed during periods of insufficient moisture. Cultivating with conventional equipment and growing annual cover crops between the rows and applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Hand hoeing or rototilling is needed in some areas. Planting on the contour conserves moisture and helps to prevent excessive runoff and erosion. Light cultivation helps to eliminate surface cracks and protects the roots.

This soil generally is not suitable as a septic tank absorption field because of the slow permeability and the wetness. A suitable alternative site is needed. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Constructing the buildings on raised, well-compacted fill material helps to overcome the wetness caused by the high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIIe-2, dryland; windbreak suitability group 4L.

WyC2—Wymore silty clay, 2 to 7 percent slopes, eroded. This deep, gently sloping, moderately well drained soil is on long ridges, divides, and side slopes in the uplands. It formed in loess. Erosion has removed most of the original surface layer. Rills and gullies form during periods of heavy rainfall in areas where the surface is not protected. Areas generally are broad and continuous and range from 10 to several hundred acres in size.

Typically, the surface layer is very dark brown, friable silty clay about 7 inches thick. The subsoil is about 35 inches thick. It is mottled. The upper part is very dark grayish brown, firm silty clay, the next part is dark grayish brown, very firm silty clay, and the lower part is grayish brown, firm silty clay loam. The underlying material to a depth of more than 60 inches is light brownish gray, mottled silty clay loam. In some areas, such as small grassland areas and areas next to drainageways, the surface layer is thicker and darker and is silty clay loam. In other areas lime concretions or hard nodules of lime are in the lower part of the subsoil.

Included with this soil in mapping are small areas of Colo, Judson, Mayberry, Nodaway, and Pawnee soils. Colo, Judson, and Nodaway soils contain less clay throughout than the Wymore soil. Colo and Nodaway soils are on bottom land. Judson soils are on foot slopes below the Wymore soil. Mayberry and Pawnee soils formed in glacial till on the lower hillsides. Also included are areas where the subsoil contains less clay and the underlying material is glacial till and, in areas where the soil is in contact with the glacial till downslope, spots that are wet early in spring. Included areas make up 5 to 15 percent of the unit.

Permeability is slow in the Wymore soil. Available water capacity is high. Runoff is medium. The depth to a perched seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderate. The shrink-swell potential is high. Tilth is fair.

Most of the acreage is cropland. Some small areas support introduced grasses and are used as pasture. A few areas are used as range.

If used for dryland farming, this soil is suited to grain sorghum, wheat, corn, soybeans, oats, alfalfa, clover, and grasses. Further erosion is a hazard. Also, cultivated crops may be adversely affected by hot, dry periods in the summer, when the plants are at the critical stage of development. The soil holds moisture tightly and does not release it fast enough to maintain the plants. Conservation tillage systems that return crop residue to the soil improve the capacity of the soil to absorb water, conserve moisture, and help to maintain the content of organic matter. Terraces, grassed waterways, and contour farming help to control erosion (fig. 14). Row crops can be grown more frequently in the cropping sequence if these measures are applied. If these measures are not applied, the soil can be protected by applying conservation tillage systems, growing clean-cultivated row crops only on a limited basis, and including close-growing small grain, legumes, or legume-grass mixtures in the cropping sequence as much as possible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or

Figure 14.—Terraces and contour farming in an area of Wymore silty clay, 2 to 7 percent slopes, eroded.

late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil is suited to range. A cover of range plants is very effective in controlling erosion. The natural plant community is mostly mid and tall grasses dominated by big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. When the plants are overgrazed or improperly harvested for hay, big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance and sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds increase. If overgrazing continues for many years, the less desirable plants, especially Kentucky bluegrass, buckbrush, snowberry, and sumac, increase in abundance.

This soil is a poor site for the trees and shrubs grown as farmstead or feedlot windbreaks and as plantings that enhance recreation areas and wildlife habitat. It generally is not suited to field windbreaks. The survival and growth rates of adapted species are fair or poor. The high content of clay, drought, competition from weeds and grasses, excessive slope and runoff, and the formation of cracks, which results from shrinking and swelling, are management concerns. The trees should be planted when the soil is moist, but not when it is wet. Supplemental watering can provide the water needed during periods of insufficient moisture. Cultivating with conventional equipment and growing annual cover crops between the rows and applying appropriate herbicides in the rows help to control undesirable weeds and grasses. Hand hoeing or rototilling is needed in some areas. Planting on the contour conserves moisture and helps to prevent excessive runoff and erosion. Light cultivation helps to eliminate surface cracks and protects the roots.

This soil generally is not suitable as a septic tank absorption field because of the slow permeability and the wetness. A suitable alternative site is needed. On sites for sewage lagoons, grading is needed to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. Constructing the buildings on raised, well-

compacted fill material helps to overcome the wetness caused by the seasonal high water table.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IIIe-2, dryland; windbreak suitability group 4L.

Zh—Zoe-Zook silty clay loams, 0 to 1 percent slopes. These deep, nearly level, poorly drained soils are on bottom land. They are occasionally flooded. They formed in clayey and silty alluvium. The landscape has a complex microrelief of slightly depressed areas and slightly higher areas. The severity of saline-alkali conditions varies widely. Areas range from 5 to 200 acres in size. They are 50 to 60 percent saline-alkali Zoe soil and 40 to 50 percent Zook soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Zoe soil has a surface layer of black, friable silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 21 inches thick. It is black and friable in the upper part and black and very dark gray and firm in the lower part. Below this is a transitional layer of dark gray, very firm silty clay about 6 inches thick. The upper part of the underlying material is dark grayish brown silty clay. The lower part to a depth of more than 60 inches is dark grayish brown, mottled silty clay loam. Clusters of salts are throughout the profile.

Typically, the Zook soil has a surface layer of black, friable silty clay loam about 8 inches thick. The subsurface layer is silty clay about 31 inches thick. The upper part is black and friable, the next part is very dark gray and firm, and the lower part is dark gray and firm. The mottled underlying material to a depth of more than 60 inches is grayish brown, mottled silty clay loam. In some areas the soil is calcareous and has a lighter colored subsurface layer.

Included with these soils in mapping are small areas of Wabash soils. These included soils are more clayey than the Zoe and Zook soils. They are in positions on the landscape similar to those of the Zoe and Zook soils. They make up less than 10 percent of the unit.

Permeability is slow in the Zoe and Zook soils. Available water capacity is moderate in the Zoe soil and high in the Zook soil. Runoff is slow on both soils. The depth to the seasonal high water table ranges from about 1 foot in wet years to 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is moderately low in the Zoe soil and high in the Zook soil. The shrink-swell potential is high in both soils. The soils may be deficient in nitrogen and phosphorous. Tilth is very poor because of the saline-alkali conditions of the Zoe soil and the high content of clay in both soils. The Zoe soil is slightly to strongly affected by saline-alkali conditions.

Most of the acreage is cultivated. A few small areas support grasses and are used as pasture, hayland, or range.

If used for dryland farming, these soils are poorly suited to cultivated crops. The main problems are the poor drainage in both soils and the soluble salts and exchangeable sodium in the Zoe soil. The salts and sodium can result in poor tilth and restrict the movement of water and air and the growth of roots. Crops on the Zoe soil are damaged because of salinity during dry periods. In areas where the soil has accumulations of salts, seed germination is poor, plants are stunted, and grain is of poor quality. A drainage system and proper chemical amendments can improve the saline-alkali conditions. When dry, the soils become very hard and droughty. Cool-seasonal small grain, such as wheat and oats, and drought-resistant crops, such as grain sorghum, can be grown. Growing legumes, such as alfalfa or sweetclover, in a grass-legume mixture improves soil structure and provides channels for water to enter the soil. Forage sorghum and grasses can be grown as livestock feed. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land, by filling low areas, and by establishing a general land grade. In places surface ditches are feasible. Excessive compaction and unnecessary tillage should be avoided, particularly when the soils are wet, because they further restrict permeability. Adding organic matter, such as crop residue, barnyard manure, and corncobs, increases the infiltration rate and the available water capacity, conserves moisture, and improves the ease of tillage.

These soils are suited to pasture. Grasses that can withstand the wetness and the saline-alkali conditions can provide forage during the summer. Overstocking causes deterioration of the pasture. Grazing when the soils are wet can cause compaction and the formation of small mounds, making haying and mowing difficult.

These soils are suited to range. They also are suited to native hay, but yields generally are low. The natural plant community is mostly short and mid grasses and grasslike plants dominated by inland saltgrass, plains bluegrass, slender wheatgrass, switchgrass, western wheatgrass, and various sedges. When the plants are overgrazed or improperly harvested for hay, the site may be dominated by inland saltgrass, foxtail barley, Kentucky bluegrass, western wheatgrass, sedges, and rushes. Overgrazing when the surface soil is wet can

cause surface compaction and the formation of small mounds, making grazing or harvesting for hay difficult.

The Zoe soil is a poor site for the trees and shrubs grown to enhance recreation areas and wildlife habitat. It generally is not suited to farmstead and feedlot windbreaks. The Zook soil is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance wildlife habitat and recreation areas. The main limitations are the wetness and the saline-alkali conditions. The trees and shrubs that can withstand the wetness and the saline-alkali conditions should be selected for planting. The areas that are not affected by the saline-alkali conditions should be selected as sites for planting. Establishing seedlings is difficult in wet years. Cultivation and weed control are hampered by excessive wetness. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment, by growing annual cover crops between the rows, and by applying appropriate herbicides in the rows. Areas near the trees can be hoed by hand or rototilled. Tillage and planting should be deferred until after the soils have begun to dry.

These soils are not suitable as septic tank absorption fields because of the slow permeability, the wetness, and the flooding. They generally are not suitable as building sites because of the flooding, the wetness, and the high shrink-swell potential. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding. Also, they should be constructed on fill material that raises the bottom of the lagoon to a sufficient height above the seasonal high water table.

Local roads and streets constructed across areas of these soils should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability unit is IVs-1, dryland. The Zoe soil is in windbreak suitability group 9S, and the Zook soil is in windbreak suitability group 2W.

Zk—Zook silt loam, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is on bottom land. It is occasionally flooded. It formed in silty and clayey alluvium. Areas range from 20 to several hundred acres in size.

Typically, the surface layer is very dark gray, very friable silt loam about 7 inches thick. The subsurface layer is about 34 inches thick. The upper part is very dark gray, very friable silt loam, and the lower part is black, very firm silty clay. The subsoil to a depth of more than 60 inches is very dark gray, mottled, very firm silty clay. In some areas the surface layer is thinner and darker.

Included with this soil in mapping are small areas of Colo and Nodaway soils. These soils contain less clay than the Zook soil. They are in positions on the landscape similar to those of the Zook soil. They make up 5 to 15 percent of the unit.

Permeability is slow in the Zook soil. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is low. Organic matter content is high. The shrink-swell potential also is high. Tilth is fair.

Most of the acreage is cropland. A few areas are pasture.

If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, and grasses. The occasional flooding is a hazard. The floodwater generally recedes within a few hours, however, and seldom severely damages crops. It can be controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. The wetness is the principal limitation, especially during the spring and during periods of high rainfall. Row crops, including corn and soybeans, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. The wetness can delay cultivating, planting, and harvesting. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Where feasible, drainage tile should be installed to intercept subsurface water. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Returning crop residue to the soil helps to maintain the content of organic matter and soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. The wetness at planting or harvesting time and competition from weeds are the main management concerns. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Where feasible, drainage tile should be installed to lower the water table. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability and destroy tilth and soil structure. Returning crop residue to the soil helps to maintain the organic matter content and good soil structure. Applications of fertilizer help to maintain fertility. The irrigation water should be applied in sufficient amounts to

meet the needs of the crop and at a rate that permits maximum absorption and results in minimum runoff.

This soil is suited to introduced grasses for pasture, generally smooth brome or a mixture of smooth brome and alfalfa or orchardgrass and alfalfa. A cover of these plants is effective in controlling erosion. Overgrazing or late haying, however, reduces the extent of the protective plant cover and causes deterioration of the pasture or hayland. Proper stocking rates, rotation grazing, and applications of nitrogen fertilizer help to maintain plant vigor and growth. Timely mowing helps to control competition from weeds.

This soil generally is a good site for the trees and shrubs grown as windbreaks. The wetness and competition from weeds are the main management concerns. Timely cultivation also is a concern. Only the species that can withstand the occasional wetness should be selected for planting. Establishing seedlings is difficult in wet years. Weeds can be controlled by cultivating with conventional equipment before and after the trees or shrubs are planted and by applying appropriate herbicides. In some years cultivating and planting should be postponed because the soil is too wet.

This soil is not suitable as a septic tank absorption field because of the flooding, the wetness, and the slow permeability. It is not suitable as a site for buildings because of the flooding, the wetness, and the high shrink-swell potential. A suitable alternative site is needed. Sewage lagoons should be diked, so that they are protected from flooding.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIw-4, dryland, and IIw-2, irrigated; windbreak suitability group 2W.

Zo—Zook silty clay loam, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is on bottom land. It is occasionally flooded. It formed in silty and clayey alluvium. Areas range from 10 to 300 acres in size.

Typically, the surface layer is black, friable silty clay loam about 5 inches thick. The subsurface layer is about 23 inches thick. It is black and very dark gray silty clay loam in the upper part and very dark gray, very firm silty clay in the lower part. The subsoil is very dark gray, mottled, very firm silty clay about 10 inches thick. The underlying material to a depth of more than 60 inches is dark grayish brown, mottled silty clay loam. In some areas the surface layer is stratified.

Included with this soil in mapping are small areas of Colo and Wabash soils. These soils are in positions on the landscape similar to those of the Zook soil. Colo soils are somewhat poorly drained. They contain less clay than the Zook soil. Wabash soils are very poorly drained and on the lower parts of the landscape. Included soils make up 10 to 15 percent of the unit.

Permeability is slow in the Zook soil. Available water capacity is high. Runoff is slow. The depth to the seasonal high water table ranges from 1 foot in wet years to about 3 feet in dry years. The water intake rate for irrigation is very low. Organic matter content is high. The shrink-swell potential also is high. Tilth is poor, and the soil can be worked only within a narrow range in moisture content.

Most of the acreage is cropland (fig. 15). If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, and grasses. The occasional flooding is a hazard. The floodwater generally recedes within a few hours, however, and seldom severely damages crops. It is controlled mainly by flood-control structures in the upstream watershed. Diversions and dikes on the local flood plain also can help to control flooding. The wetness is the principal limitation, especially during the spring and during periods of high rainfall. Row crops, including corn and soybeans, can be grown several years in succession, but measures that control weeds, plant diseases, and insects are needed. The wetness can delay cultivating, planting, and harvesting. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Where feasible, drainage tile should be installed to intercept subsurface water. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability. Returning crop residue to the soil helps to maintain the content of organic matter and soil structure. Applications of fertilizer help to maintain fertility.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. The wetness at planting or harvesting time and competition from weeds are the main management concerns. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by land grading and leveling. Where feasible, drainage tile should be installed to lower the water table. Excessive compaction and unnecessary tillage should be avoided, particularly when the soil is wet, because they further restrict permeability and destroy tilth and soil structure. Returning crop residue to the soil helps to maintain the organic matter content and good soil structure.

Figure 15.—Corn in an area of Zook silty clay loam, 0 to 1 percent slopes.

Applications of fertilizer help to maintain fertility. The irrigation water should be applied in sufficient amounts to meet the needs of the crop and at a rate that permits maximum absorption and results in minimum runoff.

This soil generally is a good site for the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas and wildlife habitat. The survival rate of adapted species is good. Establishing seedlings may be difficult in wet years. Tillage and planting should be deferred until after the soil has begun to dry. Weed control is a major management concern. Herbaceous vegetation is abundant and persistant on this soil. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment, by growing annual cover crops between the rows, and by applying appropriate herbicides in the rows. Areas near the trees can be hoed by hand or rototilled.

This soil is not suitable as a septic tank absorption field because of the flooding, the slow permeability, and the wetness. It is not suitable as a site for buildings because of the flooding, the wetness, and the high shrink-swell potential. A suitable alternative site is

needed. Sewage lagoons should be diked, so that they are protected from flooding.

Local roads and streets constructed across areas of this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well-compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and by wetness. Installing a good surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to provide the needed surface drainage.

The capability units are IIw-4, dryland, and IIw-1, irrigated; windbreak suitability group 2W.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; for windbreaks; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

William E. Reinsch, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 78 percent of the farmland in Nemaha County is cropland (*5*). The largest acreage is used for corn and soybeans, which are grown on 68 percent of the cropland. Other crops are wheat, sorghum, alfalfa hay, and oats. Pasture makes up about 20 percent of the farmland.

Cropland Management

Good cropland management helps to control erosion and runoff, conserves moisture, maintains tilth and fertility, and maintains or improves drainage. The sequence of crops grown on a field and the management applied to the field should preserve tilth and fertility, maintain a protective plant cover, and control weeds, insects, and diseases. Cropping systems vary according to the soils on which they are used. On Pawnee clay loam, 3 to 9 percent slopes, for example, a high percentage of grasses and legumes is needed in the cropping sequence to help maintain tilth and control erosion. On Kennebec silt loam, 0 to 1 percent slopes, however, a higher percentage of row crops can be included in the cropping sequence.

Most of the soils in Nemaha County are suitable for crop production. On a large acreage in the uplands, however, conservation measures are needed to reduce the hazard of erosion. Other major management needs are applications of fertilizer, weed control, and irrigation.

Erosion control. Erosion is a very severe hazard on all class IIIe and IVe soils used as cropland. If the soils assigned to these capability subclasses are cultivated, intensive management is needed to reduce erosion to an acceptable level.

Terraces, contour farming, grassed waterways, and a conservation tillage system that leaves crop residue on

the surface help to control erosion (fig. 16). Leaving crop residue on the surface and growing a protective plant cover help to prevent sealing and crusting of the surface during and after periods of heavy rainfall. In winter, stubble catches drifting snow and thus increases the moisture supply. The overall hazard of erosion can be reduced if the less erodible and more productive soils are used for row crops and the more erodible soils are used for close-grown crops, such as small grain and alfalfa, or for hay and pasture.

Working the soil helps to prepare a seedbed, helps to control weeds, and provides a favorable medium for plants to grow. Excessive tillage, however, breaks down the granular structure in the surface layer that is needed for good soil tilth. Therefore, the soil should be tilled only when tillage is essential. Various methods of conservation tillage are used in Nemaha County. No-till, till-plant, and disk or chisel planting are well suited to row crops. Planting corn or sorghum into soybean

Figure 16.—Terraces and contour farming in an area of Sharpsburg soils used for corn and wheat.

residue without tilling the soil is a typical example of a no-till conservation tillage system. Grasses can be established by drilling the seeds into a cover of stubble without further seedbed preparation.

Fertilizer. Soils tests are needed to determine the kinds and amounts of nutrients that should be added to determine the soils used for cultivated crops. The kind of crop to be grown, the availability of moisture, and the previous cropping history affect the kinds and amounts of fertilizer that should be applied. Certain crops, such as corn, are heavy users of nitrogen, and other crops, such as alfalfa, are heavy users of phosphorus.

On all soils used for nonlegume crops, nitrogen fertilizer is beneficial, but it is especially beneficial on eroded soils. Nitrogen stimulates plant growth. If the subsoil is dry, somewhat less nitrogen is needed than if the subsoil is moist. If a grain or forage crop immediately follows a legume in the cropping sequence, less nitrogen generally is needed because legumes fix nitrogen in the soil and make it available to the succeeding crop.

Because it is not leached through the soil profile, phosphate fertilizer should be incorporated or worked into the soil. It is beneficial on all upland soils, particularly the eroded soils. The content of phosphorus generally is higher in the soils on bottom land than in upland soils, but all soils should be checked for phosphorus deficiencies. Legumes especially benefit from applications of phosphate fertilizer.

Calcium or lime is an important component in the soil. It affects plant growth and soil reaction. Reaction determines, to a great extent, the availability of elements, such as phosphorus, nitrogen, and minor nutrients. Some soils in the county, such as Ida and Zoe, are calcareous and contain free carbonates. These carbonates sometimes restrict the availability of phosphorus and minor elements. The other soils in the county generally have a slight to strong degree of acidity and could benefit from applications of lime. Soils should be tested to determine the amount of lime needed. Liming an acid soil helps to make other elements available for plant growth.

Zinc is the minor element most likely to be deficient in eroded soils and in soils that have been scalped during the construction of terraces. The content of potassium generally is very high in all the soils in Nemaha County.

Weed control. Unwanted plants can be controlled by crop rotations and by applications of herbicide and pesticide. Rotating different crops in a planned sequence also improves productivity and increases the content of organic matter. The kinds and amounts of herbicide applied to the soil should be carefully controlled. The colloidal clay and humus fraction of the soil is responsible for most of the chemical activity in the soil. Applications of an excessive amount of herbicide result in crop damage on sandy soils, which have a low content of colloidal clay, and on soils that have a moderately low or low organic matter content. Applications of agricultural pesticides help to control the undesirable forms of plant and animal life on and in the soil. The Cooperative Extension Service's guide for herbicide use provides further information about weed control (*4*).

Irrigation. About 5,000 acres in Nemaha County was irrigated in 1981. Irrigation is used mainly to supplement rainfall during critical stages of plant growth. The critical stages occur in July or early in August, during the pollination of corn or soybeans and during early seed development of the plants. In a year of normal rainfall, 4 to 8 inches of additional water is applied to the fields by gravity or sprinkler irrigation systems. Most of the water comes from rivers, streams, and reservoirs. Only a few deep wells supply irrigation water.

On soils that have slopes of 2 to 7 percent, such as Wymore and Mayberry soils, a sprinkler system is the most practical method of irrigation. The conservation measures that help to control erosion on nonirrigated cropland also help to control erosion on irrigated land. They include terraces, contour farming, grassed waterways, and a conservation tillage system that leaves a protective cover of crop residue on the soil. Measures that maintain the terraces and grassed waterways are needed. During dry periods in July and August, when small surface cracks have formed, the soil is receptive to water and the crop plants have reached their peak growth and formed a vegetative canopy over the soil. This canopy protects the soil from the forceful impact of waterdrops, either from the sprinkler system or from heavy rainstorms. Sprinkler irrigation is least efficient on hot and windy days during July and August because the water is lost through evaporation and the wind causes uneven distribution. Efficiency is improved by watering during the evenings or on cool, calm days.

In some soils, such as Wymore silty clay, 2 to 7 percent slopes, eroded, permeability is slow and the water intake rate for irrigation is very low. In clean-cultivated areas and during early stages of crop growth in the spring, applying water at a rate slow enough for the soil to absorb it all is difficult. If a sprinkler system is used, the surface layer becomes saturated, and the downward movement of water is restricted. Also, the soil is subject to severe erosion during heavy rainstorms. A conservation tillage system that leaves crop residue on the surface and terraces help to control erosion. They are especially needed if sprinklers are used during periods in the spring before a crop canopy has developed.

Sprinkler irrigation can be used for special conservation purposes. It can be used in areas where new crops and new grasses for pasture are established on sloping soils and in areas where supplemental water for windbreaks is needed.

Nearly level soils used for row crops are suited to a gravity or furrow irrigation system. Examples of nearly level soils in Nemaha County are Kennebec silt loam, 0 to 1 percent slopes; Nodaway silt loam, 0 to 1 percent slopes; Wymore silty clay loam, 0 to 2 percent slopes; and Zook silty clay loam, 0 to 1 percent slopes. Land leveling helps to achieve proper drainage. It increases the efficiency of irrigation because water is distributed evenly throughout leveled fields. In the flatter fields, the length of the rows and the amount of water applied are determined mainly by the rate of water intake or by the permeability of the soils.

Soils suited to irrigation generally have a high available water capacity, or hold about 2 inches of available moisture for each foot of soil. A crop that utilizes moisture to a depth of 3 feet has about 6 inches of available moisture. The maximum efficiency of water use by plants can be obtained if irrigation is started when about half of the stored water has been used by the plants. Thus, if a soil holds 6 inches of available water, irrigation can be started when about 3 inches has been used by the crop.

All of the soils in Nebraska are assigned to irrigation design groups. These groups are described in an irrigation guide for Nebraska (*10*), which is part of the technical specifications for conservation in Nebraska. Assistance in planning and designing an irrigation system is available in the local office of the Soil Conservation Service or the Cooperative Extension Service.

Pasture

In Nemaha County pastures of introduced grasses consist mainly of cool-season grasses, which start to grow early in spring and reach their peak growth in May or June. These grasses are dormant during July and August and start to grow again in the fall. For this reason, the grasses grown in the pastured areas should include grasses or temporary pastures of sudangrass. These grasses attain the peak growth during July and August. A combination of cool-season and warm-season grasses provides green plants during the entire growing season.

Rotation grazing allows for regrowth of the grasses and legumes used for pasture. A planned grazing system in which pastures of cool-season plants are grazed in rotation improves forage quality during the grazing season and thus also improves livestock performance. A planned grazing system maximizes forage quality, livestock performance, and plant growth by matching livestock numbers with the forage production of a pasture. The most commonly grown introduced grasses on cool-season pastures are smooth brome and orchardgrass. Other cool-season grasses and legumes that are adapted to the soils and climate in Nemaha County are creeping foxtail, intermediate wheatgrass, bromegrass, reed canarygrass, alfalfa, birdsfoot trefoil, and cicer milkvetch. When planted as a single species on nonirrigated land, some native warm-season grasses provide high quality forage during the summer if a planned grazing system is applied. Switchgrass, big bluestem, and indiangrass are the most desirable grasses for this use.

Introduced pasture grasses can be grazed in spring and fall, after they reach a height of 5 or 6 inches. Until they reach this height, they grow on food reserves stored in their roots and rhizomes. Grazing too early in spring or too late in fall reduces the vigor of the plants.

Introduced grasses respond well to applications of fertilizer. Soil tests and estimates of the amount of available soil moisture should be used to determine the amounts and kinds of fertilizer needed. Applications of nitrogen generally are needed to improve the growth of grasses, and phosphate fertilizer generally is needed to improve the growth of legumes. Because grasses and legumes improve tilth and soil structure, add organic matter, and help to control erosion, they are ideal for use in a conservation cropping system. They can be included with grain crops in the cropping sequence.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well-managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

About 137,320 acres in Nemaha County, on about 52 percent of the total acreage, meets the soil requirements for prime farmland. The map units that are considered prime farmland are listed in table 6. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 6. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or

cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-8 or IIIe-8.

The total acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Rangeland

Prepared by Peter N. Jensen, range conservationist, Soil Conservation Service.

About 2,000 acres in Nemaha County, or 1 percent of the agricultural land, is rangeland. Of this acreage, about 500 acres is cropland that has been seeded to a mixture of adapted native grasses and is used as summer pasture. The rangeland occurs mainly as areas of the Monona-Ida association, in the eastern part of the county. This association is described under the heading "General Soil Map Units." Scattered areas of rangeland are in the other associations on uplands. The average size of the livestock farms is about 320 acres.

The livestock farms generally raise small herds of cows and calves. Most of the calves are sold in the fall as feeders. The rangeland is generally grazed from late in spring to early in fall. The livestock graze smooth brome in the spring and corn or milo stalks in the fall and early in winter. They are fed alfalfa, hay, silage, or both during the rest of the winter.

Much of the rangeland has been depleted by overgrazing. The overgrazed areas support low-vigor forage plants. Many also support an abundance of weeds and shrubs and trees on the steeper slopes. Productivity can be increased and the condition of the range improved by a planned grazing system that includes proper grazing use and by measures that control brush and weeds. In areas of cropland where soil losses exceed tolerable limits, range seeding can help to control erosion. Technical assistance in developing a forage management system and in reseeding cropland can be obtained from the local office of the Soil Conservation Service.

Woodland

Prepared by Keith A. Ticknor, forester, Soil Conservation Service.

About 13,900 acres in Nemaha County, or about 5 percent of the total acreage, is forested. The forested acreage has steadily declined, mainly because woodland has been cleared and converted to cropland or pasture. The largest tracts of forest land are on the bluffs along the Missouri River. Other wooded tracts occur as irregularly shaped areas and narrow bands along streams and rivers, as strips in upland drainageways, and as narrow areas on steep breaks along streams. The forest land is divided into two main forest cover types: oak-hickory and bottomland hardwoods.

The Missouri River bluffs in areas of the Monona-Ida association, which is described under the heading "General Soil Map Units," support a variant of the white oak-red oak-hickory forest cover type. The dominant species are bur oak, black oak, and bitternut and shagbark hickories. The associated species commonly include Kentucky coffeetree, hackberry, American and red elms, green ash, chinkapin oak, eastern hophornbeam, black walnut, eastern redbud, American basswood, eastern cottonwood, and roughleaf dogwood.

The bottom land in the Onawa-Haynie-Albaton and Nodaway-Zook-Ackmore associations support the hackberry-American elm-green ash and cottonwood forest cover types. Eastern cottonwood, black willow, and American sycamore dominate in areas close to the Missouri River. The dominant species in the other bottom land areas are hackberry, green ash, and American and red elms. The chief associated species are black walnut, boxelder, mulberry, silver maple, honeylocust, Kentucky coffeetree, and American basswood. The upland drainageways support numerous species, mainly eastern cottonwood, black willow, boxelder, and green ash.

The bur oak forest cover type is on the steep slopes adjacent to streams in areas of the Pawnee-Nodaway-Gymer association. Some of the stands are made up almost entirely of bur oak, but some elms, hickories, blackberry, green ash, and black walnut also grow in these areas.

Most of the trees in the county have commercial value for wood products, but only a small part of the forest land is managed for commercial tree production. Most wooded areas are privately owned and make up only a small acreage of the farms.

Most of the soils in Nemaha County have good potential for Christmas trees and the trees used for sawtimber, firewood, veneer, and other wood products. The soils generally are used as cropland, however, and are unlikely to be converted to forest land. Much of the

best timber has been cleared from areas along the Missouri River. These areas can produce trees of the highest value. The other forested areas generally are on the steepest slopes, which are less productive than the areas along the river and produce trees of low value. Small isolated areas on bottom land that cannot be easily farmed are attractive sites for woodland.

Windbreaks and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

Windbreaks and environmental plantings are established on most of the farmsteads in Nemaha County. They either were on the site when the farmstead was established or were later planted by the land owners. Siberian elm and eastern redcedar are the dominant species. Other species include green ash, silver maple, northern catalpa, pin oak, eastern cottonwood, boxelder, and lilac. Also, farmsteads commonly are landscaped with Scotch pine, Austrian pine, or white pine (fig. 17). Planting around the farmstead is a continual need because old trees deteriorate after they pass maturity, because some trees die as a result of insects, diseases, or storms, and because new plantings are needed in areas where farming has expanded.

The field windbreaks in the county occur only as hedgerows of osageorange. They mark property lines and field boundaries and are used as living fences and a source of posts. Many of the hedgerows have been removed because of the expansion of fields.

In order for windbreaks and environmental plantings to fulfill their intended purpose, the trees or shrubs selected for planting should be suited to the soil on the site. Selecting suitable species helps to obtain maximum survival and growth rates. Permeability, available water capacity, fertility, texture, and soil depth greatly affect the growth rate.

Trees and shrubs can be easily established in Nemaha County. Competition from weeds and grasses is the cause of most failures. As a result, properly preparing

Figure 17.—Conifers in a windbreak that protects buildings and livestock from wind and snow.

the site prior to planting and controlling the competing vegetation after planting are the major concerns in establishing and maintaining a windbreak.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well-prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

At the end of each map unit description, the soil has been assigned to a windbreak suitability group. These groups are based primarily on the suitability of the soil for the locally adapted species, as is indicated by their growth and vigor. Detailed interpretations for each windbreak suitability group in the county are provided in the Technical Guide, which is available in the local office of the Soil Conservation Service.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Robert O. Koerner, biologist, Soil Conservation Service, helped prepare this section.

A study concerning the potential for outdoor recreation in Nemaha County was published in 1967 (*6*). Representatives of county, state, and federal agencies and local private organizations evaluated and appraised various kinds of recreation. The kinds of recreational enterprises evaluated were vacation sites; cottages and homesites; camping areas; picnic and sports areas; fishing waters; golf courses; hunting areas; natural, scenic, and historic areas; riding stables; shooting preserves; vacation farms and ranches; and water sports areas. Most of the recreational enterprises had some potential for future development. Rated as having high potential were vacation cabins, cottages and homesites, and small game hunting areas that have a good population of bobwhite quail. The potential of all other enterprises was medium.

The bluffs along the Missouri River provide scenic beauty. These areas of irregular terrain support native hardwoods of oak, elm, and ash; shrub undergrowth; and native grasses. They provide an expansive view of the Missouri River.

Indian Cave State Park is on the breaks along the Missouri River. It is one of the more scenic state parks in southeastern Nebraska. It provides opportunities for hiking, horseback riding, camping, and picnicking.

Brownville, a state recreation area along the Missouri River, offers river access for boating and fishing. This 23-acre area provides picnic facilities and one shelter and has adequate camping facilities for 25 units. Brownville is a National Historic Register Site. Other National Historic Register sites in Nemaha County include the Captain Meriweather Lewis Dredge, southeast of Brownville, and the Thomas J. Majors Farmstead, west of Peru.

Farm ponds and watershed structures provide sites for fishing, picnicking, and hunting (fig. 18). Farm pond fishing is limited, but the Missouri River provides good opportunities for catching catfish, northern pike, carp, walleye, and sauger. The river also provides opportunities for boating, and the areas along the river provide opportunities for hunting and picnicking.

The wildlife hunted during the regular hunting season in Nemaha County include mourning dove; deer; small game, such as rabbits and squirrels; and upland game birds, such as bobwhite quail and ring-necked pheasant.

Technical assistance in improving the recreation facilities in Nemaha County is available in the field office of the Soil Conservation Service at Auburn.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning,

Figure 18.—A farm pond in Nemaha County. The pond provides opportunities for recreation and helps to control erosion.

design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, or by limited use.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Robert O. Koerner, biologist, Soil Conservation Service, helped prepare this section.

Wildlife habitat in Nemaha County varies, depending on the soil, topography, slope, and drainage pattern. The Little Nemaha River flows from the northwest corner of the county to the southeastern part, where it empties into the Missouri River. The Little Nemaha, its tributaries, and the adjacent bottom land provide excellent habitat for whitetail deer, bobwhite quail, ring-necked pheasant, squirrel, cottontail rabbit, raccoon, and opossum.

The areas along the other streams, including Honey Creek, Long Branch, and Muddy Creek, provide riparian habitat. They support diverse vegetation. The woody plants include bur oak, red oak, black oak, smooth sumac, hawthorn, hackberry, American elm, Siberian elm, cottonwood, willow, green ash, black walnut, hickory, American hornbeam, buckbrush, gooseberry, currant, mulberry, plum, and chokecherry. The native grasses include big and little bluestems, switchgrass, indiangrass, sideoats grama, blue grama, and buffalograss. Reed canarygrass grows in the wetter areas. Smooth brome is abundant. These areas also support many native wildflowers and forbs, such as goldenrod, compass plant, roundhead lespedeza, Dutchman's breeches, adderstongue, meadow anemone, columbine, lambsquarters, and phlox. This wide range of plants provides diversity for wildlife species. The wooded drainageways provide travel lanes for wildlife to move from the stream systems to the cropland in the uplands and back or to move to other areas within the stream systems. Scattered hedgerows, field borders, and trees and shrubs along fence lines and roadways provide added food and escape cover. Farmsteads, shelterbelts, and field windbreaks provide winter food and escape cover for many wildlife species. Farm ponds provide water for wildlife, but they are limited in number.

A conservation tillage system that leaves crop residue on the surface and contour stripcropping add winter and nesting cover for upland game birds and for nongame birds and mammals.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface

stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, sunflower, giant ragweed, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, dogwood, and cottonwood. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and skunkbush sumac.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, reed canarygrass, cordgrass, rushes, sedges, and cattail.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are waterfowl feeding areas and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and coyote.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include songbirds, woodpeckers, squirrels, raccoon, deer, and skunk.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the

performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excessive gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined

by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils; loamy soils that have a relatively high content of clay; soils that have only 20 to 40 inches of suitable material; soils that have an appreciable amount of gravel, stones, or soluble salts; or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey; have less than 20 inches of suitable material; have a large amount of gravel, stones, or soluble salts; have slopes of more than 15 percent; or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 18.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 19). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

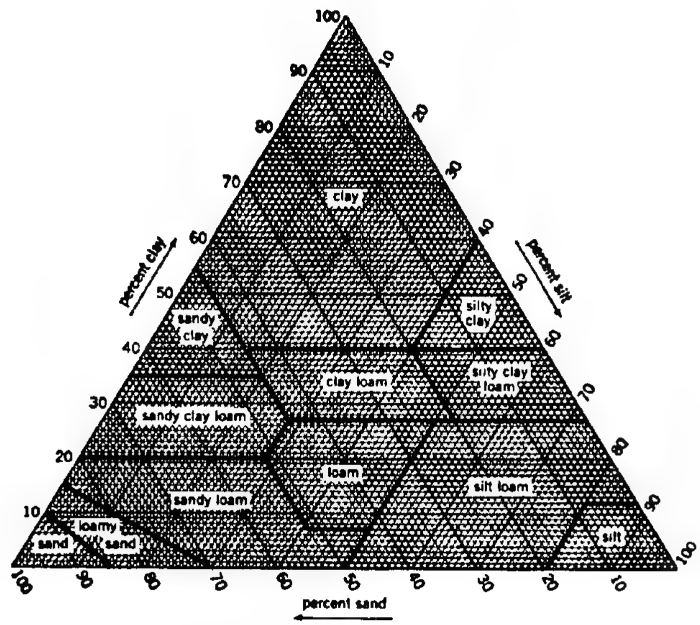

Figure 19.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in

group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 18.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to absorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume

change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Mechanical and Chemical Analyses

During the course of this survey, samples of soil profiles were collected for mechanical and chemical analyses by the National Soil Survey Laboratory, Soil Conservation Service, in Lincoln, Nebraska. Pedons of Sharpsburg, Wabash, Wymore, Zoe, and Zook soils were sampled in Nemaha County. Pedons of Pawnee, Wabash, and Wymore soils were sampled in Pawnee County. Data from the samples are recorded in a soil survey investigation report (*8*). This information is useful in classifying soils and in developing concepts of soil genesis. It also is helpful in estimating available water capacity, susceptibility to soil blowing, fertility, tilth, and other properties that affect soil management.

Engineering Index Test Data

Table 18 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Nebraska Department of Roads.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Specific gravity—T 100 (AASHTO). The group index number that is part of the AASHTO classification is computed by the Nebraska Modification System.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*9*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 19 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences between orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning a horizon that has an accumulation of clay, plus *udolls*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*7*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*9*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Ackmore Series

The Ackmore series consists of deep, somewhat poorly drained, moderately permeable soils on bottom land. These soils formed in alluvium. Slopes are 0 to 1 percent.

Ackmore soils are commonly adjacent to Colo, Nodaway, Wabash, and Zook soils. Colo soils have a mollic epipedon. They are in positions on the landscape similar to those of the Ackmore soils. Nodaway soils are silty throughout. They are in the slightly higher landscape

positions. Wabash and Zook soils are clayey throughout. They are in the slightly lower landscape positions.

Typical pedon of Ackmore silt loam, 0 to 1 percent slopes, 2,150 feet west of the center of sec. 30, T. 5 N., R. 15 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

C1—7 to 19 inches; mixed dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) silt loam, mixed grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) dry; weak very fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

C2—19 to 25 inches; mixed very dark gray (10YR 3/1) and dark gray (10YR 4/1) silty clay loam, mixed dark grayish brown (10YR 4/2) and light brownish gray (10YR 6/2) dry; massive; hard, firm; neutral; abrupt smooth boundary.

Ab—25 to 44 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; hard, friable; neutral; clear smooth boundary.

Cg—44 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; few fine distinct very dark grayish brown (10YR 3/2) mottles; massive; hard, friable; neutral.

The thickness of the solum is less than 10 inches and corresponds to the thickness of the A horizon. The upper 20 to 30 inches is silt loam or silty clay loam and is stratified or mixed.

The A and C horizons have value of 3 or 4 and chroma of 1 or 2. The C horizon is silt loam or silty clay loam. The Ab horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 1 or less. The Cg horizon has higher values than those in the overlying horizons.

Albaton Series

The Albaton series consists of deep, poorly drained, very slowly permeable soils. These soils are on bottom land in the valley of the Missouri River and in some areas are in swales and depressions. They formed in calcareous, clayey alluvium. Slopes are 0 to 1 percent.

In most areas the upper part of the C horizon in these soils is darker and thicker than is definitive for the Albaton series. This difference, however, does not alter the usefulness or behavior of the soils. The Albaton soil in the map unit Percival-Albaton silty clays, 0 to 2 percent slopes, is not a taxadjunct to the series.

Albaton soils are commonly adjacent to Haynie and Onawa soils. The adjacent soils are slightly higher on the landscape than the Albaton soils. Also, Haynie soils are less clayey, and Onawa soils have thinner clayey layers and are loamy below a depth of about 24 inches.

Typical pedon of Albaton silty clay, 0 to 1 percent slopes, 2,590 feet south and 50 feet west of the northeast corner of sec. 1, T. 6 N., R. 14 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; strong very fine blocky structure; slightly hard, firm; mildly alkaline; abrupt smooth boundary.

Cg1—8 to 14 inches; stratified very dark grayish brown (2.5Y 3/2) and grayish brown (2.5Y 5/2) silty clay, gray (10YR 5/1) and light gray (10YR 7/1) dry; many fine prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, firm; stratified with layers of silt loam; strong effervescence; mildly alkaline; clear smooth boundary.

Cg2—14 to 24 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; common fine distinct yellowish brown (10YR 5/6) mottles; massive; very hard, very firm; strong effervescence; mildly alkaline; clear smooth boundary.

Cg3—24 to 60 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; many medium prominent yellowish brown (10YR 5/6) mottles; massive; very hard, very firm; few pressure faces; many medium lime concretions; violent effervescence; mildly alkaline.

The thickness of the solum is 6 to 9 inches and corresponds to the thickness of the A horizon. The soils are mildly alkaline or moderately alkaline throughout.

The A horizon has value of 3 or 4 (4 or 5 dry) and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam and silt loam. The Cg horizon has value of 3 to 5 (4 to 6 dry). It is silty clay or clay.

Benfield Series

The Benfield series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in material weathered from clayey shale. Slopes range from 6 to 30 percent.

The climate under which these soils formed is more humid than is typical for the Benfield series. This difference, however, does not alter the usefulness or behavior of the soils.

Benfield soils are commonly adjacent to Kipson, Sharpsburg, Sogn, and Wymore soils. Kipson soils are shallow or very shallow over silty shale. They are on the slightly higher parts of the landscape. Sharpsburg and Wymore soils are deep and formed in loess. They are in positions on the landscape similar to those of the Benfield soils. Sogn soils are shallow or very shallow over limestone. They are on the slightly higher parts of the landscape.

Typical pedon of Benfield silty clay loam, in an area of Benfield-Kipson silty clay loams, 6 to 11 percent slopes,

eroded, 2,275 feet west and 325 feet south of the northeast corner of sec. 4, T. 5 N., R. 14 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; few fine limestone fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bt—8 to 20 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; very hard, friable; calcareous seams and root channels; moderately alkaline; clear wavy boundary.

C—20 to 26 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5 6/2) dry; massive; hard, friable; violent effervescence; moderately alkaline; clear smooth boundary.

Cr—26 to 60 inches; light brownish gray (2.5Y 6/2) bedded shale, light gray (2.5Y 7/2) dry; massive; slightly hard, firm; violent effervescence; moderately alkaline.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The mollic epipedon is 6 to 8 inches thick.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. Some pedons have a BA horizon. The Bt horizon has hue of 5YR to 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is silty clay loam or silty clay in which the content of clay ranges from 38 to 45 percent. It is neutral to moderately alkaline.

Blencoe Series

The Blencoe series consists of deep, somewhat poorly drained soils on bottom land in the valley of the Missouri River. These soils formed in clayey and silty alluvium. Permeability is slow in the upper part of the soils, moderate in the next part, and very slow in the lower part. Slopes range from 0 to 2 percent.

Blencoe soils are similar to Onawa soils and are commonly adjacent to Albaton, Haynie, and Onawa soils. Onawa soils do not have a clayey underlying layer and do not have a mollic epipedon. Albaton soils are clayey throughout. They are at the lower elevations. Haynie soils are coarser textured throughout than the Blencoe soils, are much lighter in color, and are much younger. Also, they are slightly higher on the landscape.

Typical pedon of Blencoe silty clay, clayey substratum, 0 to 2 percent slopes, 1,100 feet south and 50 feet west of the center of sec. 5, T. 6 N., R. 15 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong very fine granular structure; very hard, very firm; neutral; abrupt smooth boundary.

A—7 to 15 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong fine granular structure; very hard, very firm; neutral; clear smooth boundary.

Bw—15 to 22 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine distinct dark brown (10YR 4/3) mottles; moderate fine prismatic structure parting to strong medium subangular blocky; very hard, very firm; neutral; gradual smooth boundary.

2Cg1—22 to 41 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles; massive; soft, very friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

3Cg2—41 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; many medium prominent reddish brown (5YR 4/4) mottles; massive; very hard, very firm; common fine lime concretions and accumulations; few pressure faces; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 18 to 24 inches. Typically, the texture is silty clay to a depth of 18 to 24 inches and silt loam at a depth of 18 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 1 or 2. It is silty clay or silty clay loam. Some pedons have a transitional horizon of loam. The 2Cg horizon has hue of 2.5Y or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 1 or 2. It is silt loam or very fine sandy loam. The 3Cg horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 or 2. In some pedons it has thin strata of silt loam.

Burchard Series

The Burchard series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 11 to 15 percent.

Burchard soils are similar to Shelby soils and are commonly adjacent to Morrill and Pawnee soils. Shelby soils do not have free carbonates within a depth of 30 inches. Morrill soils are redder than the Burchard soils and do not have carbonates. They are in the lower landscape positions. Pawnee soils are more clayey than the Burchard soils. They are commonly on the higher parts of the landscape.

Typical pedon of Burchard clay loam, 11 to 15 percent slopes, 2,000 feet north and 1,100 feet east of the southwest corner of sec. 10, T. 4 N., R. 13 E.

A1—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable; neutral; clear smooth boundary.

A2—8 to 13 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; slightly hard, friable; neutral; clear wavy boundary.

Bt1—13 to 19 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm; mildly alkaline; clear wavy boundary.

Bt2—19 to 28 inches; brown (10YR 5/3) clay loam, pale brown (10YR 6/3) dry; moderate fine prismatic structure; hard, firm; few fine pebbles; mildly alkaline; clear smooth boundary.

BC—28 to 42 inches; mixed light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) clay loam, light yellowish brown (2.5Y 6/4) dry; moderate medium blocky structure; hard, firm; few fine pebbles; many lime accumulations and concretions; few fine prominent yellowish brown (10YR 5/8) iron stains; slight effervescence; moderately alkaline; clear wavy boundary.

C—42 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; moderate medium blocky structure; hard, friable; few pebbles; many coarse lime accumulations; violent effervescence; moderately alkaline.

The thickness of the solum ranges from about 24 to 50 inches. The thickness of the mollic epipedon ranges from 8 to 18 inches. The depth to free carbonates ranges from 13 to 30 inches. The content of pebbles and cobblestones on the surface and in the profile ranges, by volume, from 1 to 5 percent.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is medium acid to neutral. It is dominantly clay loam, but the range includes loam. The Bt horizon has value of 3 to 6 (5 to 7 dry) and chroma of 3 or 4. The C horizon has value of 6 or 7 (moist or dry) and chroma of 2 or 3. It is mildly alkaline or moderately alkaline.

Colo Series

The Colo series consists of deep, somewhat poorly drained, moderately permeable soils on bottom land. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Colo soils are commonly adjacent to Judson, Kennebec, and Nodaway soils. Judson soils are well drained and are on foot slopes and stream terraces. Kennebec and Nodaway soils are moderately well drained and are in the slightly higher landscape positions. Nodaway soils do not have a mollic epipedon.

Typical pedon of Colo silty clay loam, 0 to 1 percent slopes, 1,600 feet east and 50 feet north of the center of sec. 32, T. 6 N., R. 14 E.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

A1—8 to 15 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable; neutral; diffuse smooth boundary.

A2—15 to 30 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable; neutral; clear smooth boundary.

AC—30 to 36 inches; very dark gray (10YR 3/1) silty clay loam, grayish brown (10YR 5/2) dry; few fine prominent reddish brown (5YR 4/4) mottles; weak medium subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.

Cg1—36 to 45 inches; dark gray (10YR 4/1) silty clay loam, grayish brown (10YR 5/2) dry; many medium prominent reddish brown (5YR 4/4) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; hard, friable; neutral; clear smooth boundary.

Cg2—45 to 60 inches; dark gray (10YR 4/1) silty clay loam, grayish brown (10YR 5/2) dry; few fine prominent dark reddish brown (5YR 3/3) mottles; weak medium subangular blocky structure; hard, friable; few fine ferro-manganese accumulations; neutral.

The thickness of the solum ranges from 30 to 54 inches. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. It is dominantly silty clay loam, but in some pedons it is silt loam in the upper part. It is commonly neutral but ranges from neutral to medium acid. Some pedons do not have an AC horizon. The C horizon commonly has value of 4, but the range includes value of 3.

Grable Series

The Grable series consists of deep, somewhat excessively drained soils on bottom land in the valley of the Missouri River. These soils formed in calcareous alluvium. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Grable soils are commonly adjacent to Haynie, Onawa, and Sarpy soils. Typically, the adjacent soils are slightly lower on the landscape than the Grable soils. Haynie soils are silty in the control section. Onawa soils are clayey in the upper part. Sarpy soils are sandy throughout.

Typical pedon of Grable very fine sandy loam, 0 to 2 percent slopes, 200 feet west and 220 feet north of the center of sec. 25, T. 7 N., R. 15 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—8 to 20 inches; stratified grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) dry; weak coarse subangular blocky structure parting to weak thin platy; soft, very friable; violent effervescence; mildly alkaline; abrupt smooth boundary.

2C2—20 to 60 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose; strong effervescence; moderately alkaline.

The thickness of the solum is less than 10 inches and corresponds to the thickness of the A horizon. The A horizon has chroma of 1 or 2. It is very fine sandy loam or silt loam. The C horizon has hue of 10YR or 2.5Y and value of 4 or 5 (5 or 6 dry). It is very fine sandy loam or silt loam. The 2C horizon is fine sand or sand.

Gymer Series

The Gymer series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in silty, reddish brown loess. Slopes range from 5 to 11 percent.

These soils do not have a mollic epipedon and have a surface layer that is slightly thinner than is definitive for the Gymer series. These differences, however, do not alter the usefulness or behavior of the soils.

Gymer soils are commonly adjacent to Marshall, Mayberry, Pawnee, Sharpsburg, and Wymore soils. Marshall soils contain less clay in the subsoil than the Gymer soils. Also, they are higher on the landscape. Mayberry and Pawnee soils formed in till. They are in the lower landscape positions. Sharpsburg and Wymore soils are less red in the subsoil than the Gymer soils. Also, they are slightly higher on the landscape.

Typical pedon of Gymer silty clay loam, 5 to 11 percent slopes, eroded, 2,000 feet north and 70 feet east of the southwest corner of sec. 31, T. 4 N., R. 15 E.

Ap—0 to 6 inches; dark brown (7.5YR 4/2) silty clay loam, brown (7.5YR 5/4) dry; strong fine granular structure; hard, firm; slightly acid; abrupt smooth boundary.

Bt—6 to 18 inches; brown (7.5YR 5/4) silty clay, light brown (7.5YR 6/4) dry; strong coarse subangular blocky structure; very hard, very firm; dark material in cracks and root channels; many clay films; slightly acid; clear smooth boundary.

BC—18 to 40 inches; strong brown (7.5YR 5/6) silty clay loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; very hard, friable; slightly acid; clear smooth boundary.

C—40 to 60 inches; reddish brown (5YR 4/4) silty clay loam, light reddish brown (5YR 6/4) dry; massive; hard, friable; slightly acid.

The thickness of the solum ranges from 36 to 60 inches. The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 to 4. The Bt horizon has hue of 7.5YR or 5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 6. It is silty clay loam or silty clay in which the content of clay ranges from 35 to 42 percent. It is medium acid to neutral. The BC horizon has hue of 7.5YR or 5YR, value of 4 or 5 (4 to 6 dry), and chroma of 4 to 6.

Haynie Series

The Haynie series consists of deep, moderately well drained soils on bottom land in the valley of the Missouri River. These soils formed in calcareous alluvium. They typically are moderately permeable throughout, but the overwash phase is slowly permeable in the upper part. Slopes range from 0 to 2 percent.

Haynie soils are commonly adjacent to Albaton, Onawa, and Sarpy soils. Albaton and Onawa soils are slightly lower on the landscape than the Haynie soils. Albaton soils are clayey throughout and Onawa soils are clayey in the upper part. Sarpy soils are sandy throughout. They are in the slightly higher landscape positions.

Typical pedon of Haynie silt loam, 0 to 2 percent slopes, 2,600 feet south and 50 feet east of the center of sec. 25, T. 7 N., R. 15 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; slightly hard, friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—8 to 40 inches; dark grayish brown (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) dry; few medium faint dark yellowish brown (10YR 4/4) mottles; weak thin platy structure; soft, very friable; thin strata of silt loam; strong effervescence; moderately alkaline; abrupt smooth boundary.

C2—40 to 60 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; many medium prominent yellowish brown (10YR 5/6) and gray (10YR 5/1) mottles; weak thin platy structure; slightly hard, friable; thin strata of very fine sandy loam; strong effervescence; moderately alkaline.

The thickness of the solum is 6 to 9 inches and corresponds to the thickness of the A horizon. The soils are mildly alkaline or moderately alkaline throughout.

The A horizon has hue of 2.5Y or 10YR and has value of 4 or 5 when dry. It is dominantly silt loam or silty clay, but the range includes very fine sandy loam. The C horizon has hue of 2.5Y or 10YR and value of 4 or 5 (5 to 7 dry). Typically, it is very fine sandy loam or silt loam, but it has thin strata of finer or coarser textured material.

Ida Series

The Ida series consists of deep, well drained, moderately permeable soils on uplands adjacent to the Missouri River. These soils formed in loess. Slopes range from 5 to 60 percent.

Ida soils are commonly adjacent to Marshall and Monona soils. The adjacent soils commonly are on the lower concave slopes. Marshall soils have a mollic epipedon. Their subsoil is more strongly expressed than that of the Ida soils and contains more clay. Monona soils are deeper to carbonates than the Ida soils and have mollic colors in the A horizon.

Typical pedon of Ida silt loam, in an area of Monona-Ida silt loams, 5 to 11 percent slopes, eroded, 200 feet north and 2,030 feet west of the southeast corner of sec. 36, T. 5 N., R. 15 E.

Ap—0 to 7 inches; brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

C—7 to 60 inches; brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; massive; soft, friable; many medium prominent reddish yellow (7.5YR 6/6) relict mottles; many fine lime accumulations; violent effervescence; moderately alkaline.

The thickness of the solum is 6 to 10 inches and generally corresponds to the thickness of the A horizon. The depth to free carbonates ranges from 0 to 10 inches.

The A horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 or 3. It is neutral to moderately alkaline. The C horizon has value of 4 or 5 (6 or 7 dry) and chroma of 3 to 5. It is mildly alkaline or moderately alkaline.

Judson Series

The Judson series consists of deep, well drained, moderately permeable soils on foot slopes and stream terraces. These soils formed in silty sediments that eroded from dark soils in the uplands. Slopes range from 0 to 6 percent.

Judson soils are commonly adjacent to Colo, Marshall, Nodaway, Sharpsburg, and Wymore soils. Colo and Nodaway soils are on bottom land. Colo soils are somewhat poorly drained, and Nodaway soils are moderately well drained. Marshall, Sharpsburg, and Wymore soils are on uplands. They formed in loess. Their A horizon is thinner than that of the Judson soils, and their B horizon is more strongly expressed.

Typical pedon of Judson silt loam, 2 to 6 percent slopes, 700 feet south and 80 feet east of the northwest corner of sec. 19, T. 6 N., R. 14 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; hard, friable; medium acid; abrupt smooth boundary.

A1—8 to 17 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, friable; medium acid; clear smooth boundary.

A2—17 to 26 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure parting to weak fine granular; slightly hard, friable; medium acid; clear smooth boundary.

Bw—26 to 41 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure parting to weak fine granular; slightly hard, friable; neutral; clear smooth boundary.

BC—41 to 60 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak fine granular; slightly hard, friable; dark grayish brown (10YR 4/2) coating on faces of peds; many fine sand grains; neutral.

The thickness of the solum ranges from 40 to more than 60 inches. The thickness of the mollic epipedon ranges from 30 to more than 50 inches.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It ranges from 20 to 36 inches in thickness. It is silt loam or silty clay loam and is medium acid to neutral. The B horizon has value and chroma of 3 or 4. The clay content in this horizon ranges from 30 to 35 percent.

Kennebec Series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on bottom land. These soils formed in silty alluvium. Slopes range from 0 to 4 percent.

Kennebec soils are commonly adjacent to Colo, Nodaway, and Zook soils. Colo soils are somewhat poorly drained and generally are in the lower landscape positions. Nodaway and Zook soils are in positions on the landscape similar to those of the Kennebec soils. Nodaway soils do not have a mollic epipedon. Zook soils contain more clay than the Kennebec soils.

Typical pedon of Kennebec silt loam, 0 to 1 percent slopes, 1,600 feet north and 125 feet west of the southeast corner of sec. 10, T. 5 N., R. 14 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A1—7 to 13 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; grayish brown (10YR 5/2) spots; weak medium subangular blocky structure parting to weak very fine granular; slightly hard, friable; slightly acid; abrupt smooth boundary.

A2—13 to 19 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable; slightly acid; gradual smooth boundary.

A3—19 to 40 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.

C—40 to 60 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles in the lower part; massive; slightly hard, friable; slightly acid.

The thickness of the solum and the thickness of the mollic epipedon range from 36 to more than 50 inches. The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is slightly acid or neutral. It is dominantly silt loam, but the range includes silty clay loam. The C horizon has value of 2 to 4 (4 or 5 dry) and chroma of 1 or 2. It is silt loam or silty clay loam. It is slightly acid or neutral.

Kipson Series

The Kipson series consists of shallow or very shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from calcareous, silty shale. Slopes range from 6 to 70 percent.

The climate under which these soils formed is more humid than is typical for the Kipson series. This difference, however, does not affect the usefulness or behavior of the soils.

Kipson soils are commonly adjacent to Benfield, Gymer, Sharpsburg, Sogn, and Wymore soils. Benfield soils are moderately deep. They are slightly lower on the landscape than the Kipson soils. Gymer, Sharpsburg, and Wymore soils formed in loess. They are lower on the landscape than the Kipson soils. Sogn soils are underlain by bedded limestone. They are higher on the landscape than the Kipson soils.

Typical pedon of Kipson silty clay loam, in an area of Sogn-Kipson complex, 6 to 30 percent slopes, 2,100 feet west and 1,350 feet north of the southeast corner of sec. 35, T. 6 N., R. 13 E.

A—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; 10 to 15 percent fragments of shale and limestone; strong effervescence; mildly alkaline; gradual smooth boundary.

Cr1—10 to 22 inches; grayish brown (10YR 5/2) silty shale, light gray (10YR 7/2) dry; massive; violent effervescence; mildly alkaline; gradual wavy boundary.

Cr2—22 to 60 inches; grayish brown (10YR 5/2) silty shale, light brownish gray (10YR 6/2) dry; massive; violent effervescence; mildly alkaline.

The thickness of the solum and the thickness of the mollic epipedon range from 6 to 12 inches. The depth to bedded, silty shale ranges from 7 to 20 inches. The A horizon has hue of 10YR or 2.5Y and a value of 2 or 3 (3 to 5 dry). It is silt loam, silty clay loam, or clay loam.

Malcolm Series

The Malcolm series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in silty deposits. Slopes range from 5 to 11 percent.

Malcolm soils are commonly adjacent to Burchard, Mayberry, and Morrill soils. The adjacent soils are higher on the landscape than the Malcolm soils. Burchard and Mayberry soils formed in glacial till. Morrill soils are redder and sandier than the Malcolm soils.

Typical pedon of Malcolm silt loam, 5 to 11 percent slopes, eroded, 2,000 feet west and 80 feet north of southeast corner of sec. 30, T. 4 N., R. 14 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

Bt—8 to 22 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; weak very fine subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

C1—22 to 32 inches; light brownish gray (2.5Y 6/2) silt loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure parting to weak thin platy; slightly hard, very friable; slightly acid; gradual smooth boundary.

C2—32 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, light gray (2.5Y 7/2) dry; massive; slightly hard, very friable; slightly acid.

The thickness of the solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 15 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). It is dominantly silt loam, but the range includes silty clay loam. The Bt horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 or 3. Some pedons have a BC horizon. The C horizon has value of 4 to 7 (6 to 8 dry) and chroma of 1 to 3. It is typically silt loam but in some pedons is very fine sandy loam in which the content of clay ranges from 12 to 18 percent.

Marshall Series

The Marshall series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in silty loess. Slopes range from 2 to 11 percent.

Marshall soils are similar to Monona soils and are commonly adjacent to Monona and Sharpsburg soils. The adjacent soils are in positions on the landscape similar to those of the Marshall soils. Monona soils contain less clay throughout than the Marshall soils, and Sharpsburg soils contain more clay in the subsoil.

Typical pedon of Marshall silty clay loam, 2 to 5 percent slopes, 50 feet north and 50 feet west of the center of sec. 8, T. 5 N., R. 15 E.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; hard, friable; slightly acid; abrupt smooth boundary.

A—9 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; hard, friable; slightly acid; clear wavy boundary.

Bw1—13 to 28 inches; dark brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

Bw2—28 to 37 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; few fine faint light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) relict mottles; moderate fine subangular blocky structure; slightly hard, friable; slightly acid; clear smooth boundary.

BC—37 to 44 inches; brown (10YR 5/3) silty clay loam, light yellowish brown (10YR 6/4) dry; common fine faint yellowish brown (10YR 5/6) relict mottles; weak coarse subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.

C—44 to 60 inches; brown (10YR 5/3) silt loam, light yellowish brown (10YR 6/4) dry; common fine faint yellowish brown (10YR 5/6) and common coarse distinct light brownish gray (10YR 6/2) relict mottles; massive; some vertical cleavage; slightly hard, very friable; common ferro-manganese accumulations; slightly acid.

The thickness of the solum ranges from 40 to 70 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. The Bw horizon has value of 3 to 5 (4 or 5 dry) and chroma of 3 and 4. It is slightly acid or medium acid. The clay content in this horizon ranges from 28 to 34 percent. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 6.

Marshall silty clay loam, 2 to 5 percent slopes, eroded, and Marshall silty clay loam, 5 to 11 percent slopes, eroded, do not have a mollic epipedon and have a thinner solum than is defined as the range for the Marshall series. These differences, however, do not alter the usefulness or behavior of the soils.

Mayberry Series

The Mayberry series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in reworked glacial material. Slopes range from 3 to 9 percent.

These soils do not have a mollic epipedon, which is definitive for the Mayberry series. This difference, however, does not alter the usefulness or behavior of the soils.

Mayberry soils are similar to Pawnee soils and are commonly adjacent to Morrill and Wymore soils. Pawnee soils are browner throughout than the Mayberry soils. Morrill soils contain less clay throughout than the Mayberry soils. Their positions on the landscape are similar to those of the Mayberry soils. Wymore soils formed in loess. They are higher on the landscape than the Mayberry soils.

Typical pedon of Mayberry clay, 3 to 9 percent slopes, eroded, 250 feet west and 300 feet north of the southeast corner of sec. 32, T. 4 N., R. 14 E.

Ap—0 to 7 inches; dark brown (7.5YR 3/2) clay, dark brown (7.5YR 4/2) dry; moderate fine granular structure; slightly hard, friable; common fine pebbles; slightly acid; abrupt smooth boundary.

Bt1—7 to 11 inches; reddish brown (5YR 4/3) clay, reddish brown (5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm; common fine pebbles; slightly acid; clear smooth boundary.

Bt2—11 to 16 inches; reddish brown (5YR 4/4) clay, reddish brown (5YR 4/4) dry; few fine prominent dark grayish brown (10YR 4/2) mottles; moderate medium prismatic structure; hard, very firm; common fine pebbles; discontinuous clay films; slightly acid; gradual wavy boundary.

Bt3—16 to 26 inches; dark brown (7.5YR 4/4) clay, light brown (7.5YR 6/4) dry; few fine faint strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure; hard, very firm; common fine pebbles; discontinuous clay films; slightly acid; gradual wavy boundary.

Bt4—26 to 60 inches; brown (7.5YR 5/4) clay, light brown (7.5YR 6/4) dry; moderate medium prismatic structure; hard, very firm; common fine pebbles; clay films on vertical faces of peds; neutral.

The thickness of the solum ranges from about 40 to more than 60 inches. The dark surface layer ranges from 5 to 10 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is dominantly clay, but the range includes clay loam and silty clay loam. Some pedons have a transitional horizon between the Ap and Bt horizons. The Bt horizon has hue of 7.5YR or 5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is neutral or slightly acid. The content of clay in this horizon ranges from 40 to 50 percent. Some pedons have a BC horizon. This horizon has hue of 7.5YR or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. It is clay or clay loam.

Monona Series

The Monona series consists of deep, well drained, moderately permeable soils on uplands adjacent to the Missouri River. These soils formed in loess. Slopes range from 2 to 40 percent.

In most areas these soils do not have the mollic epipedon that is definitive for the Monona series. This difference, however, does not alter the usefulness or behavior of the soils. The Monona soils in the map unit Monona-Ida silt loams, 30 to 60 percent slopes, and in the Monona-Kipson complex, 30 to 70 percent slopes, are not taxadjuncts to the series.

Monona soils are similar to Marshall soils and are commonly adjacent to Ida and Marshall soils. Marshall soils are in positions on the landscape similar to those of the Monona soils. Their subsoil is more strongly expressed than that of the Monona soils and contains more clay. Ida soils are shallower to carbonates than the Monona soils and do not have a mollic epipedon. They are on convex slopes.

Typical pedon of Monona silt loam, 2 to 5 percent slopes, eroded, 1,400 feet north and 500 feet east of the center of sec. 33, T. 4 N., R. 16 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

BA—7 to 12 inches; dark brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable; neutral; gradual smooth boundary.

Bw—12 to 24 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable; neutral; gradual smooth boundary.

BC—24 to 39 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, friable; neutral; gradual smooth boundary.

C—39 to 60 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/3) dry; common medium distinct strong brown (7.5YR 5/6) and common medium distinct grayish brown (2.5Y 5/2) mottles; weak coarse prismatic structure; soft, friable; neutral.

The thickness of the solum ranges from 24 to 42 inches. The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is medium acid to neutral. The Bw horizon has value of 4 or 5 (5 or 6 dry) and chroma of 3 or 4. It is slightly acid or neutral. It is dominantly silt loam, but the range includes silty clay loam in which the content of clay is less than 30 percent. The C horizon has value of 5 (6 or 7 dry) and chroma of 3 to 6. It is neutral or mildly alkaline.

Morrill Series

The Morrill series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in glacial outwash. Slopes range from 5 to 11 percent.

These soils do not have the mollic epipedon that is definitive for the Morrill series. This difference, however, does not alter the usefulness or behavior of the soils.

Morrill soils are commonly adjacent to Mayberry, Pawnee, Sharpsburg, and Wymore soils. The adjacent soils are somewhat higher on the landscape than the Morrill soils. Also, they contain more clay in the subsoil. Sharpsburg and Wymore soils formed in loess.

Typical pedon of Morrill clay loam, 5 to 11 percent slopes, eroded, 1,500 feet west and 100 feet north of the southeast corner of sec. 18, T. 6 N., R. 13 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

Bt1—9 to 19 inches; reddish brown (5YR 4/4) clay loam, reddish brown (5YR 5/4) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm; dark material along cracks; shiny faces on vertical peds; common sand grains and pebbles; slightly acid; clear smooth boundary.

Bt2—19 to 27 inches; dark brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm; common sand grains and pebbles; slightly acid; clear smooth boundary.

BC—27 to 33 inches; brown (7.5YR 5/4) sandy clay loam, light brown (7.5YR 6/4) dry; weak coarse

subangular blocky structure; slightly hard, friable; common sand grains and pebbles; slightly acid; gradual smooth boundary.

C1—33 to 39 inches; brown (10YR 5/3) clay loam, pale brown (10YR 6/3) dry; many medium distinct very pale brown (10YR 7/3) specks; weak coarse subangular blocky structure; slightly hard, friable; common sand grains and pebbles; slightly acid; clear smooth boundary.

C2—39 to 60 inches; yellowish brown (10YR 5/4) loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; slightly hard, friable; coatings on some vertical peds; some silty strata; common sand grains and small pebbles; slightly acid.

The thickness of the solum ranges from 30 to 50 inches. The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is clay loam or loam. The Bt horizon has hue of 7.5YR or 5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 5. It is clay loam or sandy clay loam. It is slightly acid or medium acid. The BC and C horizons have hue of 7.5YR or 10YR, value of 4 or 5 (4 to 6 dry), and chroma of 3 to 6. They are loam, clay loam, or sandy clay loam. They commonly have thin strata of gravelly material.

Moville Series

The Moville series consists of deep, somewhat poorly drained soils on bottom land in the valley of the Missouri River. These soils formed in silty and clayey alluvium. Permeability is moderate in the upper part of the profile and very slow in the lower part. Slopes are 0 to 1 percent.

Moville soils are commonly adjacent to Albaton and Nodaway soils. Albaton soils are clayey throughout. They are in the slightly lower landscape positions. Nodaway soils are silty throughout. They are in the slightly higher landscape positions.

Typical pedon of Moville silt loam, 0 to 1 percent slopes, 1,400 feet north and 1,000 feet west of the center of sec. 12, T. 6 N., R. 14 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

C—7 to 28 inches; stratified very dark grayish brown (10YR 3/2) and dark grayish brown (2.5Y 4/2) silt loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; few fine prominent dark yellowish brown (10YR 4/4) mottles; some horizontal cleavage; slightly hard, very friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

2Ab1—28 to 38 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; strong fine granular structure; very hard, firm; thin strata of lighter colored material; mildly alkaline; abrupt smooth boundary.

2Ab2—38 to 60 inches; black (N 2/0) silty clay, dark gray (N 4/0) dry; moderate medium blocky structure; very hard, firm; mildly alkaline.

The thickness of the solum is less than 10 inches and corresponds to the thickness of the A horizon. The upper 18 to 30 inches is silt loam or very fine sandy loam.

The A horizon has value of 3 or 4. The 2Ab horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 or less and chroma of 1 or less. A buried B horizon is common.

Nodaway Series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on bottom land. These soils formed in stratified, silty recent alluvium. Slopes range from 0 to 4 percent.

Nodaway soils are commonly adjacent to Colo, Kennebec, Wabash, and Zook soils. Colo and Kennebec soils are in positions on the landscape similar to those of the Nodaway soils. Kennebec soils are dark to a depth of more than 20 inches. Colo, Wabash, and Zook soils contain more clay than the Nodaway soils. Colo soils are somewhat poorly drained. Wabash soils are very poorly drained, and Zook soils are poorly drained. Wabash and Zook soils are in the lower areas.

Typical pedon of Nodaway silt loam, 0 to 1 percent slopes, 1,700 feet north and 90 feet west of the southeast corner of sec. 31, T. 5 N., R. 15 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

C1—7 to 13 inches; mixed very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) silt loam, grayish brown (10YR 5/2) dry; massive; distinct bedding planes; slightly hard, friable; neutral; clear smooth boundary.

C2—13 to 60 inches; stratified very dark gray (10YR 3/1) and grayish brown (10YR 5/2) silt loam, grayish brown (10YR 5/2) and gray (10YR 5/1) dry; common fine distinct dark brown (7.5YR 3/2) iron stains; massive; distinct bedding planes; slightly hard, friable; neutral.

The thickness of the solum is 6 to 10 inches and corresponds to the thickness of the A horizon. Reaction is neutral or slightly acid throughout the profile.

The A horizon has value of 3 (4 or 5 dry) and chroma of 1 or 2. The C horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2. It is dominantly silt loam, but in some pedons individual strata are very fine sandy loam or silty

clay loam. A dark silty clay loam or silt loam buried soil is commonly at a depth of 36 to more than 70 inches.

Onawa Series

The Onawa series consists of deep, somewhat poorly drained soils on bottom land in the valley of the Missouri River. These soils formed in calcareous, clayey, loamy, and silty alluvium. Permeability is slow in the upper part of the profile and moderate or moderately rapid in the lower part. Slopes are 0 to 1 percent.

Onawa soils are commonly adjacent to Albaton, Haynie, and Percival soils. Albaton soils are clayey throughout. They are in the slightly lower landscape positions. Haynie soils are silty throughout. They are in the slightly higher landscape positions. Percival soils are clayey in the upper part and sandy in the lower part. They are in positions on the landscape similar to those of the Onawa soils.

Typical pedon of Onawa silty clay, 0 to 1 percent slopes, 1,000 feet west and 50 feet south of the northeast corner of sec. 7, T. 4 N., R. 16 E.

Ap—0 to 8 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; moderate fine granular structure; very hard, firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

Cg1—8 to 20 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; strong fine blocky structure; very hard, firm; strong effervescence; mildly alkaline; clear smooth boundary.

2Cg2—20 to 38 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; common fine distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; soft, very friable; violent effervescence; moderately alkaline; abrupt smooth boundary.

2Cg3—38 to 47 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; common bedding planes; loose violent effervescence; moderately alkaline; abrupt smooth boundary.

2Cg4—47 to 51 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; massive; common bedding planes; soft, very friable; violent effervescence; moderately alkaline; abrupt smooth boundary.

3Cg5—51 to 60 inches; dark grayish brown (2.5Y 4/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; violent effervescence; moderately alkaline.

The thickness of the solum is 6 to 9 inches and corresponds to the thickness of the A horizon. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is silty clay, silty clay loam, or silt loam. The Cg1 horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 dry), and chroma of 1 or 2. The 2Cg horizon has colors similar to those of the Cg1 horizon. It is typically stratified silt loam and very fine sandy loam, but it commonly has thin strata of silty clay. The 3Cg horizon has colors similar to those of the 2Cg horizon.

Pawnee Series

The Pawnee series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 3 to 9 percent.

Pawnee soils are similar to Mayberry soils and are commonly adjacent to Burchard, Mayberry, Shelby, and Wymore soils. Mayberry soils are redder in the subsoil than the Pawnee soils. Burchard and Shelby soils contain less clay in the subsoil than the Pawnee soils. Wymore soils formed in loess on the higher parts of the landscape.

Typical pedon of Pawnee clay loam, 3 to 9 percent slopes, 2,550 feet south and 700 feet west of the northeast corner of sec. 34, T. 4 N., R. 12 E.

Ap—0 to 11 inches; very dark gray (10YR 3/1) clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; few pebbles; neutral; clear smooth boundary.

BA—11 to 19 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable; few pebbles; neutral; clear smooth boundary.

Bt1—19 to 27 inches; dark yellowish brown (10YR 4/4) clay, yellowish brown (10YR 5/4) dry; common medium distinct dark gray (10YR 4/1) and many coarse distinct yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; extremely hard, very firm; thin shiny coatings on faces of peds; few pebbles; neutral; clear smooth boundary.

Bt2—27 to 48 inches; dark yellowish brown (10YR 4/4) clay, yellowish brown (10YR 5/4) dry; many coarse distinct yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; extremely hard, very firm; thin shiny coatings on faces of peds; few pebbles; neutral; clear smooth boundary.

C—48 to 60 inches; light brownish gray (10YR 6/2) clay loam, pale brown (10YR 6/3) dry; many medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; hard, firm; many ferro-manganese accumulations; few medium lime accumulations; few pebbles; mildly alkaline.

The thickness of the solum ranges from about 40 to 55 inches. The dark surface layer ranges from 4 to 12 inches in thickness. The content of pebbles and

cobblestones on the surface and in the profile ranges, by volume, from less than 1 percent to 3 percent.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is neutral or slightly acid. It is dominantly clay loam or clay, but the range includes loam. The Bt horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. It ranges from medium acid to neutral. The pH generally increases abruptly with increasing depth. The C horizon has hue of 10YR to 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 2 to 4. It is dominantly clay loam, but in some pedons it has strata of loam or clay. It is mildly alkaline or moderately alkaline.

Pawnee clay, 3 to 9 percent slopes, eroded, does not have the mollic epipedon that is definitive for the Pawnee series. This difference, however, does not alter the usefulness or behavior of the soil.

Percival Series

The Percival series consists of deep, somewhat poorly drained soils on bottom land in the valley of the Missouri River. These soils formed in calcareous, clayey alluvium over sandy alluvium. Permeability is slow in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Percival soils are commonly adjacent to Albaton, Haynie, and Onawa soils. Albaton soils are clayey throughout. They are in the lower landscape positions. Haynie soils are silty throughout. They are in the slightly higher landscape positions. Onawa soils are silty in the lower part. They are in positions on the landscape similar to those of the Percival soils.

Typical pedon of Percival silty clay, in an area of Percival-Albaton silty clays, 0 to 2 percent slopes, 2,400 feet east and 200 feet south of the northwest corner of sec. 31, T. 6 N., R. 16 E.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine granular structure; hard, friable; mildly alkaline; abrupt smooth boundary.

Cg1—6 to 15 inches; mixed dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium blocky structure; very hard, firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

Cg2—15 to 23 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; many medium prominent strong brown (7.5YR 5/6) mottles; massive; common bedding planes; very hard, firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

2C—23 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; few fine distinct strong brown (7.5YR 5/6) mottles; single grain; loose; strong effervescence; mildly alkaline.

The thickness of the solum is less than 10 inches and corresponds to the thickness of the A horizon. The depth to sandy material ranges from 15 to 30 inches. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon has hue of 2.5Y or 10YR, value of 3 (5 or 6 dry), and chroma of 1 or 2. It is silty clay or silty clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 or 2. It is silty clay or clay. The 2C horizon has value of 4 or 5 (6 or 7 dry). It is fine sand or loamy fine sand.

Sarpy Series

The Sarpy series consists of deep, excessively drained, rapidly permeable soils. These soils commonly are on bottom land adjacent to old or present channels of the Missouri River. They formed in calcareous, sandy alluvium. Slopes range from 0 to 3 percent.

Sarpy soils are commonly adjacent to Albaton, Haynie, and Percival soils. The adjacent soils generally are slightly lower on the landscape than the Sarpy soils. Albaton soils are clayey. Haynie soils are silty in the control section. Percival soils are clayey in the upper part.

Typical pedon of Sarpy loamy fine sand, 0 to 3 percent slopes, 1,000 feet east and 1,200 feet south of the northwest corner of sec. 8, T. 4 N., R. 17 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grain; loose; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—6 to 12 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose; slight effervescence; mildly alkaline; clear smooth boundary.

C2—12 to 60 inches; grayish brown (10YR 5/2) fine sand, light brownish gray (10YR 6/2) dry; single grain; loose; strong effervescence; mildly alkaline.

The thickness of the solum is 4 to 9 inches and corresponds to the thickness of the A horizon. The A horizon has value of 3 or 4 (4 or 5 dry) and chroma of 1 to 3. It is loamy fine sand or fine sand. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 or 6 dry), and chroma of 2 to 4. It is dominantly fine sand or loamy fine sand. In some pedons, however, it has strata of silt loam below a depth of 40 inches. It is mildly alkaline or moderately alkaline.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained, moderately slowly permeable soils on uplands (fig. 20). These soils formed in silty loess. Slopes range from 0 to 11 percent.

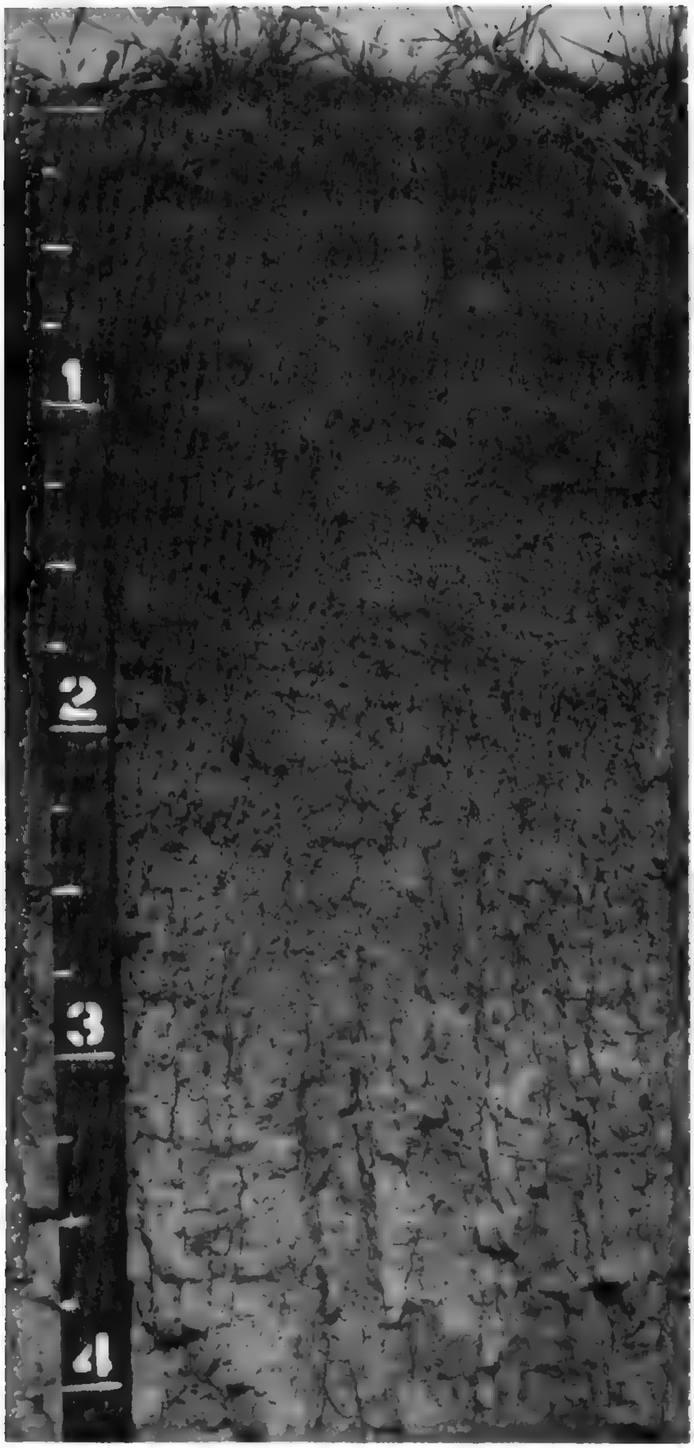

Figure 20.—Profile of Sharpsburg silty clay loam, a deep soil that has a well-developed subsoil. Depth is marked in feet.

Sharpsburg soils are similar to Wymore soils and are commonly adjacent to Marshall, Mayberry, Morrill, Pawnee, and Wymore soils. Wymore soils contain more clay in the subsoil than the Sharpsburg soils. They are in the lower landscape positions. Marshall soils contain less clay in the subsoil than the Sharpsburg soils. They are in positions on the landscape similar to those of the Sharpsburg soils. Mayberry, Morrill, and Pawnee soils formed in glacial deposits. They are lower on the landscape than the Sharpsburg soils.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, 150 feet south and 60 feet west of the northeast corner of sec. 17, T. 5 N., R. 14 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

AB—11 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable; tongues of A material; medium acid; gradual smooth boundary.

Bt1—18 to 24 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm; coatings on all peds; medium acid; gradual smooth boundary.

Bt2—24 to 32 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm; coatings on all peds; medium acid; gradual smooth boundary.

Bt3—32 to 40 inches; dark brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) dry; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure; hard, firm; coatings on vertical peds; medium acid; gradual smooth boundary.

BC—40 to 49 inches; brown (10YR 5/3) silty clay loam, light yellowish brown (10YR 6/4) dry; few medium distinct strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure; hard, friable; medium acid; gradual smooth boundary.

C—49 to 60 inches; brown (10YR 5/3) silty clay loam, very pale brown (10YR 7/4) dry; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; hard, friable; common coarse distinct light brownish gray (10YR 6/2 moist) relict mottles; many ferro-manganese accumulations; slightly acid.

The thickness of the solum ranges from 40 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 to 3. It is medium acid or slightly acid. The Bt horizon has value of 4 or 5 (4 to 6 dry) and chroma of 3 or 4. It is silty clay loam or silty clay. The C horizon has value of 4 to 6 and chroma of 3 or 4. It is slightly acid or neutral.

Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded, and Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded, have a surface layer that is thinner than is defined as the range for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Shelby Series

The Shelby series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 5 to 30 percent.

Shelby soils are similar to Burchard soils and commonly are adjacent to Pawnee, Sharpsburg, and Wymore soils. Burchard soils are shallower to free carbonates than the Shelby soils. Pawnee, Sharpsburg, and Wymore soils have more clay in the subsoil than the Shelby soils. Also, they generally are higher on the landscape. Sharpsburg and Wymore soils formed in loess.

Typical pedon of Shelby clay loam, 5 to 11 percent slopes, 1,600 feet east and 70 feet south of the northwest corner of sec. 8, T. 4 N., R. 13 E.

A1—0 to 9 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak very fine granular structure; slightly hard, friable; neutral; clear smooth boundary.

A2—9 to 17 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.

Bt1—17 to 30 inches; dark brown (10YR 4/3) clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, firm; few pebbles and few clay films; neutral; clear smooth boundary.

Bt2—30 to 42 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; common medium prominent strong brown (7.5YR 5/6) relict mottles; moderate coarse subangular blocky structure; hard, firm; common medium ferro-manganese accumulations; few pebbles; neutral; clear smooth boundary.

C—42 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few coarse prominent strong brown (7.5YR 5/6) relict mottles; massive; hard, firm; few pebbles; neutral.

The thickness of the solum ranges from 40 to 55 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. The Bt horizon has value of 3 to 5 (4 to 7 dry) and chroma of 3 or 4. It is slightly acid or neutral. The average content of the clay in this horizon ranges from 32 to 35 percent. The C horizon has value of 5 or 6 (6 or 7 dry) and chroma of 2 to 4. It is neutral to moderately alkaline.

Sogn Series

The Sogn series consists of shallow or very shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed mainly in material weathered from limestone. Slopes range from 6 to 30 percent.

Sogn soils are commonly adjacent to Benfield, Gymer, Kipson, Sharpsburg, and Wymore soils. Benfield and Kipson soils formed in material weathered from shale. They are lower on the landscape than the Sogn soils. Gymer, Sharpsburg, and Wymore soils formed in loess. They are higher on the landscape than the Sogn soils.

Typical pedon of Sogn loam, in an area of Sogn-Kipson complex, 6 to 30 percent slopes, 1,780 feet west and 60 feet north of the southeast corner of sec. 35, T. 6 N., R. 13 E.

A—0 to 8 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; soft, friable; 10 to 15 percent fragments of weathered limestone; violent effervescence; moderately alkaline; abrupt smooth boundary.

R—8 to 60 inches; white (N 8/0) level-bedded limestone; material in cracks in the limestone.

The thickness of the solum and the depth to bedrock typically are 8 inches but range from 4 to 20 inches. The thickness of the mollic epipedon is the same as the thickness of the solum. Reaction is neutral to moderately alkaline.

The A horizon has hue of 7.5YR to 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is typically loam, but the range includes silt loam and silty clay loam.

Wabash Series

The Wabash series consists of deep, very poorly drained, very slowly permeable soils on bottom land. These soils formed in clayey alluvium. Slopes are 0 to 1 percent.

Wabash soils are commonly adjacent to Zoe and Zook soils. The adjacent soils are in positions on the landscape similar to those of the Wabash soils. Zoe soils have a higher content of soluble salts and exchangeable sodium than the Wabash soils. Zook soils have less clay throughout than the Wabash soils.

Typical pedon of Wabash silty clay, 0 to 1 percent slopes, 250 feet south and 100 feet east of the northwest corner of sec. 24, T. 6 N., R. 13 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate very fine granular structure; hard, friable; slightly acid; abrupt smooth boundary.

A—9 to 18 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate coarse blocky structure parting to strong fine granular; very hard, firm; shiny faces on most peds; slightly acid; diffuse smooth boundary.

Bg1—18 to 32 inches; very dark gray (5Y 3/1) clay, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) and few fine faint gray (5Y 5/1) mottles; strong fine blocky structure; extremely hard, very firm; shiny faces on most peds; common medium ferro-manganese pellets; dark material in cracks; mildly alkaline; diffuse smooth boundary.

Bg2—32 to 60 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; common fine distinct dark yellowish brown (10YR 4/4) and few fine faint gray (5Y 5/1) mottles; strong fine blocky structure; extremely hard, very firm; shiny faces on most peds; common medium ferro-manganese pellets; few pressure faces; neutral.

The thickness of the solum and the depth to free carbonates range from 40 to more than 60 inches. The A horizon has hue of 10YR to 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or is neutral in hue. It is medium acid or slightly acid. It is silty clay or silty clay loam. The Bg horizon has hue of 10YR to 5Y, value of 2 to 4 (3 or 4 dry), and chroma of 1 or 2 or is neutral in hue. It is slightly acid to mildly alkaline. The content of clay in the 10- to 40-inch control section ranges from 46 to 60 percent.

Wymore Series

The Wymore series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slopes range from 0 to 7 percent.

Wymore soils are similar to Sharpsburg soils and are commonly adjacent to Gymer, Mayberry, Morrill, and Pawnee soils. Sharpsburg soils contain less clay in the subsoil than the Wymore soils. Also, they are higher on the landscape. Gymer soils are well drained and formed in reddish brown loess. They are in the lower landscape positions. Mayberry, Morrill, and Pawnee soils formed in glacial till. They are lower on the landscape than the Wymore soils.

Typical pedon of Wymore silty clay, 2 to 7 percent slopes, eroded, 1,450 feet north and 120 feet west of the southeast corner of sec. 27, T. 5 N., R. 12 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; slightly hard, friable; medium acid; abrupt smooth boundary.

Bt1—7 to 13 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; strong fine blocky structure; hard, firm; coatings of A material on peds; shiny faces on peds; medium acid; clear smooth boundary.

Bt2—13 to 26 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; few fine distinct dark brown (7.5YR 4/4) mottles; strong medium blocky structure; very hard, very firm coatings of A material on peds; shiny faces on peds; slightly acid; clear smooth boundary.

Bt3—26 to 35 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; many medium prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to strong medium blocky; very hard, very firm; slightly acid; clear smooth boundary.

BC—35 to 42 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; many coarse prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to strong medium blocky; hard, firm; neutral; clear smooth boundary.

C—42 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; many coarse prominent strong brown (7.5YR 5/8) mottles; massive; hard, friable; common medium ferro-manganese accumulations; neutral.

The thickness of the solum is typically 42 inches but ranges from 33 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. It is silty clay or silty clay loam. It is medium acid or slightly acid. The Bt1 horizon has value of 3 or 4 (moist or dry) and chroma of 1 or 2. It is medium acid or slightly acid. The Bt2 horizon has value of 3 or 4 (5 or 6 dry) and dominantly has chroma of 2 or 3. The lower part of the B horizon has few or common mottles ranging from yellowish red to olive brown. The Bt horizon is silty clay in which the content of clay ranges from 42 to 55 percent. The C horizon is slightly acid or neutral.

Zoe Series

The Zoe series consists of deep, poorly drained, slowly permeable, saline-alkali soils on bottom land. These soils formed in alluvium. Slopes are 0 to 1 percent.

Zoe soils are commonly adjacent to Wabash and Zook soils. The adjacent soils are in positions on the

landscape similar to those of the Zoe soils. They have a higher content of soluble salts and exchangeable sodium than the Zoe soils. Wabash soils are very poorly drained.

Typical pedon of Zoe silty clay loam, in an area of Zoe-Zook silty clay loams, 0 to 1 percent slopes, 1,500 feet south and 125 feet east of the northwest corner of sec. 6, T. 6 N., R. 13 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; hard, friable; salts on faces of peds; neutral; abrupt smooth boundary.

A—7 to 12 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, friable; salts on faces of peds; mildly alkaline; abrupt smooth boundary.

Az1—12 to 18 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine blocky structure; very hard, firm; common salt clusters; mildly alkaline; clear smooth boundary.

Az2—18 to 28 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; moderate medium blocky structure; very hard, very firm; many salt clusters; slight effervescence in seams; mildly alkaline; clear smooth boundary.

ACz—28 to 34 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; moderate medium blocky structure; very hard, very firm; many salt clusters; slight effervescence in seams; mildly alkaline; clear smooth boundary.

Cz—34 to 45 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; massive; very hard, very firm; many salt clusters; few lime concretions; slight effervescence; mildly alkaline; clear smooth boundary.

C—45 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common medium prominent strong brown (7.5YR 5/8) mottles; massive; very hard, firm; few salt clusters; slight effervescence; mildly alkaline.

The thickness of the solum and the thickness of the mollic epipedon range from 26 to 36 inches. The conductivity of the saturation extract ranges from 1 to 3 millimhos per centimeter within a depth of 12 inches and increases to 4 to 8 millimhos below that depth.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 0 to 2. The C horizon has value of 2 to 4 (5 or 6 dry) and chroma of 1 or 2.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on bottom land. These soils formed in silty and clayey alluvium. Slopes are 0 to 1 percent.

Zook soils are commonly adjacent to Colo, Kennebec, Nodaway, Wabash, and Zoe soils. The somewhat poorly drained Colo and moderately well drained Kennebec and Nodaway soils are along stream channels. They contain less clay than the Zook soils. The very poorly drained Wabash soils have more clay in the upper part than the Zook soils. They are in positions on the landscape similar to those of the Zook soils. Zoe soils have a higher content of soluble and alkali salts than the Zook soils. They are in the slightly lower landscape positions.

Typical pedon of Zook silty clay loam, 0 to 1 percent slopes, 825 feet west and 330 feet north of the southeast corner of sec. 16, T. 6 N., R. 13 E.

Ap—0 to 5 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate medium granular; slightly hard, friable; neutral; abrupt smooth boundary.

A1—5 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; strong medium blocky structure; slightly hard, friable; neutral; clear smooth boundary.

A2—9 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.

A3—16 to 21 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; strong medium blocky structure; hard, firm; neutral; clear smooth boundary.

A4—21 to 28 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; strong coarse prismatic structure parting to strong medium blocky; very hard, very firm; neutral; clear smooth boundary.

Bg—28 to 38 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles; strong coarse prismatic structure parting to strong medium blocky; very hard, very firm; neutral; clear smooth boundary.

Cg1—38 to 48 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; common medium distinct strong brown (7.5YR 5/6) mottles; moderate coarse prismatic structure parting to moderate medium blocky; hard, firm; neutral; clear smooth boundary.

Cg2—48 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; many medium distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to moderate medium granular; slightly hard, friable; neutral.

The thickness of the solum ranges from 36 to 60 inches. The thickness of the mollic epipedon ranges from 36 to 50 inches.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. It is silty clay loam or silt loam in the upper part. It is

medium acid to neutral. The Bg and C horizons have hue of 10YR to 5Y, value of 3 to 5 (4 or 6 dry), and chroma of 1 or 2. They are slightly acid to mildly alkaline. Some pedons have mottles of high value and chroma below a depth of 28 inches.

Formation of the Soils

Soil forms when soil-forming processes act on deposited or accumulated geologic material. The characteristics of the soils at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Some time is always needed for the differentiation of soil horizons. Usually, a long time is needed for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the unconsolidated mineral material in which a soil forms. It determines the chemical and mineralogical composition of the soil. The soils in Nemaha County formed in limestone or shale residuum, glacial till, glacial outwash, Loveland loess, Peorian loess, colluvium, and alluvium.

Only a small acreage of the soils in the county formed in material weathered from limestone or shale because this material generally is deeply covered. Kipson soils formed in silty material weathered from shale, and Sogn soils formed in loamy material weathered from limestone. Both of these soils are shallow or very shallow because the solid rock is resistant to weathering. They are vegetated dominantly by grasses or stands of mixed grasses, shrubby brush, and trees.

Glacial till is on the uplands throughout the county, especially in the southwestern part. It is generally grayish or brownish. Till is a fine-earth mixture of silt, sand, and clay studded with pebbles and some stones. In places it has small pockets of sand and gravel. Burchard and Pawnee soils formed in glacial till.

Reddish to brownish glacial outwash, or reworked till, is exposed throughout the uplands. Morrill soils formed in loamy outwash containing many sand grains and a few pebbles. Mayberry soils formed in reworked glacial material that is clayey and contains sand and pebbles.

Loveland loess generally is exposed on upland slopes in the county. It is reddish brown material less than 10 feet thick. It is older than Peorian loess and is more oxidized. Gymer soils formed in Loveland loess.

Peorian loess is the most extensive parent material in the county. It is silty material that is grayish, brownish, or yellowish brown. It ranges from a few feet thick to about 100 feet thick in some areas. Generally, it is yellowish brown and silty along the Missouri River and becomes progressively browner and more clayey in the areas farthest from the river. Ida, Marshall, Monona, Sharpsburg, and Wymore soils formed in Peorian loess on uplands.

Colluvium is on foot slopes or the lower side slopes adjacent to the steeper uplands. It is deep, friable material recently deposited by the combined effects of gravity and moving water. It is generally brown silt loam or silty clay loam. Judson soils formed in colluvial material.

The recent alluvium in the minor valleys in the county consists of silty and clayey sediments washed from upland slopes and deposited on flood plains. Colo, Kennebec, Nodaway, and Zook soils formed in this alluvial material. In many areas they are frequently or occasionally flooded. As a result, fresh deposits of alluvial material continue to accumulate.

The recent alluvium in the major valleys in the county consists of sandy, silty, and clayey sediments carried from areas farther upstream and deposited on wide flood plains. In the lower lying areas adjacent to the major rivers, the soils may be flooded several times a year. In the areas farther away and in the higher landscape positions, flooding occurs only during major floods. Albaton, Haynie, Onawa, and Sarpy soils formed in alluvial material along the Missouri River.

Climate

Climate affects the formation of soils both directly and indirectly. In the past, cold temperatures activated

glaciers that left till material. Also, dust particles accumulated as loess deposits during dry and windy periods. At present, the movement of rainfall affects the shape of the landscape and alternating freezing and thawing periods in the soil hasten the disintegration of the parent material. Climate affects soil formation indirectly through its effect on the amount and kind of vegetation and animal life on and in the soil.

The continental climate in Nemaha County is characterized by seasonal variations. In winter, which is moderately long, temperatures are cold, commonly below 0 degrees F. In spring, temperatures are cool and precipitation is considerable. In summer, temperatures are warm, often higher than 95 degrees. Thunderstorms are common in summer and late in spring. The fall is characterized by mild temperatures and occasional periods of rainfall. The mean annual temperature is about 52 degrees, and the annual precipitation is about 34 inches.

The amount of precipitation that penetrates the surface and moves through the profile is enough to leach carbonates and other soluble elements to a depth of at least 2 feet in most soils. Except for some of the steeper soils and the soils on bottom land, most of the soils in Nemaha County are slightly acid in the surface layer. Some of the steeper soils have carbonates at or near the surface either because they are eroded or because they are so steep that the water runs off the surface rather than soaking in and leaching the soluble elements.

Plant and Animal Life

Grasses, trees, burrowing animals, micro-organisms, earthworms, and other kinds of plants and animals on or in the soil affect soil formation. The kinds of plants and animals are determined by climate, parent material, age of the soil, relief, drainage, and other factors.

Before the soils were cultivated, the dominant vegetation in Nemaha County was mid and tall grasses. This kind of vegetation provides an abundance of organic matter, which affects the physical and chemical properties of the soil and darkens the surface layer. The fibrous roots of these grasses penetrate the soil, make it porous, and foster the development of granular structure. The plant roots transport minerals in solution from the lower part of the soil to the surface. Many of the areas along the Missouri River support oaks mixed with hickories and cedars. When these trees die and decay, they provide a more acid environment than is normal in the county.

Micro-organisms, insects, earthworms, and burrowing rodents have a beneficial effect on the fertility structure, and productivity of the soil. Micro-organisms convert organic matter into humus, which provides plant nutrients. Small burrowing rodents, earthworms, and insects aerate, loosen, and mix the soil by making openings and channels in the soil. Their remains add organic matter to the soil.

Relief

Relief affects soil formation through its effect on runoff, erosion, and drainage. Runoff is more rapid on steep and very steep slopes than on more gentle slopes. Less water penetrates the surface in areas where runoff is rapid. As a result, these areas support less vegetation than the areas where runoff is slower. The water can remove the soil material almost as fast as the soil forms.

Some of the nearly level soils on bottom land are somewhat poorly drained or poorly drained because of slow runoff or a moderately high water table. Zook and Albaton soils are examples.

Time

Time enables relief, climate, and plant and animal life to change the parent material into a soil. Generally, the parent material has to be in place for some time before genetic profiles and thick horizons can form. If the parent material has been in place only for a short time, the soils are weakly developed because climate and vegetation have not acted on the soils for very long. Kennebec and Nodaway soils are weakly developed. They formed in recent alluvial deposits during the past few centuries or, in some areas, during the past few years.

Marshall, Sharpsburg, and Wymore soils formed in Peorian loess. They have been in place long enough for the formation of well-defined, genetically related horizons. Pawnee soils, which formed in glacial till, also have well-defined, genetically related horizons. Because these soils have been forming for a shorter period than the soils that formed in Peorian loess, however, they are less deeply leached of carbonates. The longer the parent material is exposed to soil formation, the more nearly the soil reaches a balance with its environment.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in

diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth, soil. The total thickness of the soil over bedrock. In this survey area the classes of soil depth are very shallow, 0 to 10 inches; shallow, 10 to 20 inches; moderately deep, 20 to 40 inches; and deep, more than 40 inches.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing

season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excessive silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay,

sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. The organic fraction of the soil. It includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. It is commonly identified as the organic material that accompanies the soil material when a soil sample is passed through a 2-millimeter sieve. In this survey area the classes of organic matter content are high, 4.0 to 8.0 percent; moderate, 2.0 to 4.0 percent; moderately low, 1.0 to 2.0 percent; and low, 0.5 to 1.0 percent.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. The removal of not more than 50 percent, by weight, of the key management plants when an area of range or pasture is grazed. Proper grazing use protects the surface by maintaining an adequate plant cover. It also maintains or improves the quality and quantity of desirable vegetation.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good,

fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey area the classes of slope are—

	Percent
Nearly level	0 to 2
Very gently sloping	1 to 3
Gently sloping	2 to 7
Strongly sloping	5 to 11
Moderately steep	11 to 17
Steep	17 to 30
Very steep	more than 30

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data were recorded in the period 1951-80 at Auburn, Nebraska]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	33.6	12.8	23.2	60	-15	0	0.90	0.27	1.41	3	7.2
February---	40.4	18.8	29.6	70	-10	16	1.15	.32	1.80	3	6.0
March------	51.1	27.8	39.5	84	-2	52	2.32	.76	3.59	5	6.2
April------	66.4	41.0	53.7	89	20	156	3.04	1.68	4.24	6	.9
May--------	76.2	51.7	64.0	93	31	438	4.40	2.74	5.89	8	.0
June-------	85.2	61.1	73.2	100	44	696	4.52	2.48	6.31	7	.0
July-------	89.6	65.5	77.6	103	50	856	4.39	1.74	6.61	7	.0
August-----	87.7	63.3	75.5	101	48	791	4.36	1.57	6.66	6	.0
September--	79.8	54.2	67.0	98	33	510	3.84	1.56	5.76	6	.0
October----	69.4	42.8	56.1	91	22	228	2.66	.54	4.31	4	.2
November---	52.3	29.9	41.1	77	6	15	1.52	.33	2.45	3	1.9
December---	39.8	19.5	29.7	67	-9	0	.98	.30	1.53	3	4.3
Yearly:											
Average--	64.3	40.7	52.5	---	---	---	---	---	---	---	---
Extreme--	---	---	---	104	-17	---	---	---	---	---	---
Total----	---	---	---	---	---	3,758	34.08	27.02	39.32	61	26.7

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data were recorded in the period 1951-80 at Auburn, Nebraska]

Probability	Temperature: 24° F or lower	Temperature: 28° F or lower	Temperature: 32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 17	April 26	May 7
2 years in 10 later than--	April 12	April 21	May 2
5 years in 10 later than--	April 3	April 12	April 24
First freezing temperature in fall:			
1 year in 10 earlier than--	October 16	October 10	September 25
2 years in 10 earlier than--	October 22	October 15	September 30
5 years in 10 earlier than--	November 2	October 24	October 10

TABLE 3.--GROWING SEASON

[Data were recorded in the period 1951-80 at Auburn, Nebraska].

Probability	Daily minimum temperature during growing season: Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	188	174	147
8 years in 10	197	181	155
5 years in 10	212	194	169
2 years in 10	228	207	182
1 year in 10	236	214	190

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Aa	Ackmore silt loam, 0 to 1 percent slopes	5,340	2.0
Ab	Albaton silty clay, 0 to 1 percent slopes	4,270	1.6
BfD2	Benfield-Kipson silty clay loams, 6 to 11 percent slopes, eroded	1,400	0.5
BfF	Benfield-Kipson silty clay loams, 11 to 30 percent slopes	570	0.2
Bn	Blencoe silty clay, clayey substratum, 0 to 2 percent slopes	1,660	0.6
BrE	Burchard clay loam, 11 to 15 percent slopes	980	0.4
Co	Colo silty clay loam, 0 to 1 percent slopes	3,600	1.4
Gn	Grable very fine sandy loam, 0 to 2 percent slopes	1,080	0.4
GyD2	Gymer silty clay loam, 5 to 11 percent slopes, eroded	6,750	2.5
Hb	Haynie silt loam, 0 to 2 percent slopes	3,370	1.3
Hd	Haynie silty clay, overwash, 0 to 2 percent slopes	1,380	0.5
Ju	Judson silt loam, 0 to 2 percent slopes	910	0.3
JuC	Judson silt loam, 2 to 6 percent slopes	11,650	4.4
Ke	Kennebec silt loam, 0 to 1 percent slopes	2,180	0.8
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes	1,810	0.7
MaD2	Malcolm silt loam, 5 to 11 percent slopes, eroded	290	0.1
McC	Marshall silty clay loam, 2 to 5 percent slopes	2,770	1.0
McC2	Marshall silty clay loam, 2 to 5 percent slopes, eroded	7,020	2.7
McD2	Marshall silty clay loam, 5 to 11 percent slopes, eroded	18,840	7.1
MeC2	Mayberry clay, 3 to 9 percent slopes, eroded	3,210	1.2
MmC2	Monona silt loam, 2 to 5 percent slopes, eroded	1,290	0.5
MmD2	Monona silt loam, 5 to 11 percent slopes, eroded	4,030	1.5
MnD2	Monona-Ida silt loams, 5 to 11 percent slopes, eroded	1,770	0.7
MnE2	Monona-Ida silt loams, 11 to 17 percent slopes, eroded	7,130	2.7
MnF2	Monona-Ida silt loams, 17 to 30 percent slopes, eroded	4,620	1.7
MnG	Monona-Ida silt loams, 30 to 60 percent slopes	3,630	1.4
MpG	Monona-Kipson complex, 30 to 70 percent slopes	1,900	0.7
MrD2	Morrill clay loam, 5 to 11 percent slopes, eroded	3,200	1.2
Mv	Moville silt loam, 0 to 1 percent slopes	500	0.2
Nc	Nodaway silt loam, 0 to 1 percent slopes	7,900	3.0
Nf	Nodaway silt loam, channeled	7,870	3.0
Ng	Nodaway-Colo silt loams, 0 to 2 percent slopes	7,210	2.7
Oc	Onawa silt loam, 0 to 1 percent slopes	1,050	0.4
On	Onawa silty clay, 0 to 1 percent slopes	4,380	1.7
PaC	Pawnee clay loam, 3 to 9 percent slopes	5,400	2.0
PbC2	Pawnee clay, 3 to 9 percent slopes, eroded	9,950	3.8
Pe	Percival-Albaton silty clays, 0 to 2 percent slopes	870	0.3
Pt	Pits, quarries	430	0.2
SaB	Sarpy loamy fine sand, 0 to 3 percent slopes	740	0.3
SbB	Sarpy-Haynie complex, 0 to 3 percent slopes	790	0.3
Sh	Sharpsburg silty clay loam, 0 to 2 percent slopes	410	0.2
ShC	Sharpsburg silty clay loam, 2 to 5 percent slopes	5,800	2.2
ShC2	Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded	13,450	5.1
ShD2	Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded	25,310	9.6
SkD	Shelby clay loam, 5 to 11 percent slopes	1,200	0.5
SkF	Shelby clay loam, 15 to 30 percent slopes	1,410	0.5
SvF	Sogn-Kipson complex, 6 to 30 percent slopes	1,560	0.6
Ud	Udorthents, silty	190	0.1
Wc	Wabash silty clay, 0 to 1 percent slopes	3,640	1.4
Wd	Wabash silty clay, 0 to 1 percent slopes, depressional	460	0.2
Wt	Wymore silty clay loam, 0 to 2 percent slopes	1,620	0.6
WtC	Wymore silty clay loam, 2 to 7 percent slopes	9,680	3.7
WyC2	Wymore silty clay, 2 to 7 percent slopes, eroded	33,680	12.6
Zh	Zoe-Zook silty clay loams, 0 to 1 percent slopes	940	0.4
Zk	Zook silt loam, 0 to 1 percent slopes	4,610	1.7
Zo	Zook silty clay loam, 0 to 1 percent slopes	2,970	1.1
	Water areas less than 40 acres in size	783	0.3
	Water areas greater than 40 acres in size	3,264	1.2
	Total	264,717	100.0

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

[Yields in the N columns are for nonirrigated soils; those in the I columns are for irrigated soils. Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Land capability		Corn		Grain sorghum	Winter wheat	Soybeans		Alfalfa hay	Smooth bromegrass
	N	I	N	I	N	N	N	I	N	N
			Bu	Bu	Bu	Bu	Bu	Bu	Tons	AUM*
Aa--------------- Ackmore	IIw	IIw	100	130	100	40	42	50	5.0	6.5
Ab--------------- Albaton	IIIw	IIIw	70	110	75	30	30	---	3.8	5.5
BfD2------------- Benfield-Kipson	IVe	---	55	---	55	25	20	---	2.5	3.5
BfF-------------- Benfield-Kipson	VIe	---	---	---	---	---	---	---	---	---
Bn--------------- Blencoe	IIw	IIw	96	130	94	36	38	50	4.0	5.0
BrE-------------- Burchard	IVe	---	60	---	65	30	25	---	3.0	4.0
Co--------------- Colo	IIw	IIw	100	130	100	40	42	50	5.0	6.5
Gn--------------- Grable	IIs	I	65	115	---	30	25	---	3.0	4.2
GyD2------------- Gymer	IVe	---	65	---	75	35	27	---	3.5	4.0
Hb--------------- Haynie	IIw	IIw	100	140	100	35	38	50	5.0	5.5
Hd--------------- Haynie	IIw	IIw	94	130	94	34	34	43	4.0	4.8
Ju--------------- Judson	I	I	112	142	105	43	43	52	5.0	6.5
JuC-------------- Judson	IIe	IIIe	108	140	103	41	42	52	4.9	6.0
Ke--------------- Kennebec	I	I	117	145	110	43	45	55	5.0	6.5
KnB-------------- Kennebec- Nodaway	IIw	IIw	100	135	100	41	42	50	4.8	5.8
MaD2------------- Malcolm	IVe	---	65	---	75	33	27	---	3.4	4.5
McC-------------- Marshall	IIe	IIIe	100	125	100	42	40	52	4.8	5.5
McC2------------- Marshall	IIe	IIIe	95	122	95	40	38	---	4.5	5.0
McD2------------- Marshall	IIIe	IVe	90	118	90	38	35	---	4.3	4.5
MeC2------------- Mayberry	IVe	---	56	---	67	32	23	---	2.8	3.5
MmC2------------- Monona	IIe	IIIe	95	120	95	40	38	---	4.8	5.0

See footnote at end of table.

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability		Corn		Grain sorghum	Winter wheat	Soybeans		Alfalfa hay	Smooth bromegrass
	N	I	N	I	N	N	N	I	N	N
			Bu	Bu	Bu	Bu	Bu	Bu	Tons	AUM*
MmD2------------ Monona	IIIe	IVe	90	115	90	38	33	---	4.7	4.5
MnD2------------ Monona-Ida	IIIe	IVe	83	110	85	35	28	---	4.5	4.2
MnE2------------ Monona-Ida	IVe	---	72	---	70	33	25	---	4.2	3.8
MnF2------------ Monona-Ida	VIe	---	---	---	---	---	---	---	---	---
MnG------------- Monona-Ida	VIIe	---	---	---	---	---	---	---	---	---
MpG------------- Monona-Kipson	VIIe	---	---	---	---	---	---	---	---	---
MrD2------------ Morrill	IVe	---	70	---	75	35	30	---	3.8	5.0
Mv-------------- Moville	IIw	IIw	92	130	90	34	36	50	4.0	5.5
Nc-------------- Nodaway	IIw	IIw	107	135	105	40	42	55	5.0	6.0
Nf-------------- Nodaway	VIw	---	---	---	---	---	---	---	---	---
Ng-------------- Nodaway-Colo	IIw	IIw	90	135	90	40	38	50	5.0	5.8
Oc-------------- Onawa	IIw	IIw	92	120	90	33	36	---	5.0	5.5
On-------------- Onawa	IIw	IIw	85	110	85	32	34	---	4.8	5.3
PaC------------- Pawnee	IIIe	---	67	---	76	36	28	---	3.5	4.0
PbC2------------ Pawnee	IVe	---	60	---	68	34	27	---	3.0	3.5
Pe-------------- Percival-Albaton	IIIw	IIIw	65	115	65	26	25	---	2.8	4.2
Pt-------------- Pits	VIIIs	---	---	---	---	---	---	---	---	---
SaB------------- Sarpy	IVs	IIIs	45	110	---	25	22	---	2.5	3.8
SbB------------- Sarpy-Haynie	IVs	---	48	---	---	25	25	---	3.0	4.0
Sh-------------- Sharpsburg	I	I	100	130	98	45	40	55	4.8	5.8
ShC------------- Sharpsburg	IIe	IIIe	93	128	93	42	37	48	4.5	5.3
ShC2------------ Sharpsburg	IIe	IIIe	88	125	90	38	35	45	4.3	5.0
ShD2------------ Sharpsburg	IIIe	IVe	82	115	87	37	32	---	4.0	4.5

See footnote at end of table.

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability		Corn		Grain sorghum	Winter wheat	Soybeans		Alfalfa hay	Smooth bromegrass
	N	I	N	I	N	N	N	I	N	N
			Bu	Bu	Bu	Bu	Bu	Bu	Tons	AUM*
SkD-------------- Shelby	IIIe	---	70	---	77	35	32	---	4.0	4.5
SkF-------------- Shelby	VIe	---	---	---	---	---	---	---	---	---
SvF-------------- Sogn-Kipson	VIs	---	---	---	---	---	---	---	---	---
Ud--------------- Udorthents	VIs	---	---	---	---	---	---	---	---	---
Wc--------------- Wabash	IIIw	IIIw	72	115	87	30	36	---	4.0	5.5
Wd--------------- Wabash	Vw	---	---	---	---	---	---	---	---	---
Wt--------------- Wymore	IIs	IIs	83	125	93	42	38	52	4.0	4.5
WtC-------------- Wymore	IIIe	---	79	---	90	38	36	---	4.0	4.5
WyC2------------- Wymore	IIIe	---	72	---	82	35	33	---	3.5	4.0
Zh--------------- Zoe-Zook	IVs	---	58	---	70	25	25	---	3.0	3.2
Zk--------------- Zook	IIw	IIw	96	125	98	39	38	45	4.5	6.0
Zo--------------- Zook	IIw	IIw	92	120	94	38	36	---	4.3	5.8

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
Aa	Ackmore silt loam, 0 to 1 percent slopes (where drained)*
Bn	Blencoe silty clay, clayey substratum, 0 to 2 percent slopes
Co	Colo silty clay loam, 0 to 1 percent slopes (where drained)*
Gn	Grable very fine sandy loam, 0 to 2 percent slopes
Hb	Haynie silt loam, 0 to 2 percent slopes
Hd	Haynie silty clay, overwash, 0 to 2 percent slopes
Ju	Judson silt loam, 0 to 2 percent slopes
JuC	Judson silt loam, 2 to 6 percent slopes
Ke	Kennebec silt loam, 0 to 1 percent slopes
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes
McC	Marshall silty clay loam, 2 to 5 percent slopes
McC2	Marshall silty clay loam, 2 to 5 percent slopes, eroded
MmC2	Monona silt loam, 2 to 5 percent slopes, eroded
Mv	Moville silt loam, 0 to 1 percent slopes (where drained)*
Nc	Nodaway silt loam, 0 to 1 percent slopes
Ng	Nodaway-Colo silt loams, 0 to 2 percent slopes (where the Colo soil is drained)*
Oc	Onawa silt loam, 0 to 1 percent slopes (where drained)*
On	Onawa silty clay, 0 to 1 percent slopes (where drained)*
Sh	Sharpsburg silty clay loam, 0 to 2 percent slopes
ShC	Sharpsburg silty clay loam, 2 to 5 percent slopes
ShC2	Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded
Wt	Wymore silty clay loam, 0 to 2 percent slopes
WtC	Wymore silty clay loam, 2 to 7 percent slopes
WyC2	Wymore silty clay, 2 to 7 percent slopes, eroded
Zk	Zook silt loam, 0 to 1 percent slopes (where drained)*
Zo	Zook silty clay loam, 0 to 1 percent slopes (where drained)*

* These soils generally have been adequately drained either by the application of drainage measures or because of the incidental drainage that results from farming, roadbuilding, and other kinds of land development.

TABLE 7.--CAPABILITY CLASSES AND SUBCLASSES

[All soils are assigned to nonirrigated capability subclasses (N). Only potentially irrigable soils are assigned to irrigated subclasses (I). Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I (N)	3,500	---	---	---
(I)	4,580	---	---	---
II (N)	90,460	41,980	45,780	2,700
(I)	47,400	---	45,780	1,620
III (N)	108,690	99,910	8,780	---
(I)	51,500	41,980	8,780	740
IV (N)	35,380	32,910	---	2,470
(I)	49,950	49,950	---	---
V (N)	460	---	460	---
VI (N)	16,220	6,600	7,870	1,750
VII (N)	5,530	5,530	---	---
VIII(N)	430	---	---	430

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Aa----------------- Ackmore	---	Silky dogwood, Amur honeysuckle, Amur privet, American cranberrybush.	Eastern redcedar, Washington hawthorn.	Honeylocust, Austrian pine, eastern white pine, hackberry, green ash.	Eastern cottonwood.
Ab----------------- Albaton	Blackhaw----------	Siberian peashrub, Tatarian honeysuckle.	Osageorange, Russian-olive, eastern redcedar, Washington hawthorn.	Hackberry, bur oak, honeylocust, green ash.	Eastern cottonwood.
BfD2*:					
Benfield----------	Siberian peashrub, Peking cotoneaster, lilac.	Amur honeysuckle, Manchurian crabapple.	Eastern redcedar, Austrian pine, Russian-olive, hackberry, green ash.	Siberian elm, honeylocust.	---
Kipson.					
BfF*:					
Benfield.					
Kipson.					
Bn----------------- Blencoe	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, silver maple, Austrian pine, green ash, golden willow, northern red oak.	Eastern cottonwood.
BrE---------------- Burchard	Peking cotoneaster	Tatarian honeysuckle, lilac, American plum.	Eastern redcedar, Russian mulberry, green ash, hackberry, bur oak.	Austrian pine, Scotch pine, honeylocust.	---
Co----------------- Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
Gn----------------- Grable	---	Tatarian honeysuckle, Siberian peashrub, lilac.	Ponderosa pine, eastern redcedar, Russian-olive, bur oak.	Golden willow, honeylocust, green ash, hackberry.	Eastern cottonwood.
GyD2--------------- Gymer	Lilac, Peking cotoneaster.	Manchurian crabapple, Siberian peashrub, Amur honeysuckle.	Eastern redcedar, Austrian pine, Russian-olive, hackberry, green ash.	Siberian elm, honeylocust.	---
Hb----------------- Haynie	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Hd----------------- Haynie	Blackhaw----------	Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, osageorange, Washington hawthorn.	Honeylocust, hackberry, bur oak, green ash.	Eastern cottonwood.
Ju----------------- Judson	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Eastern redcedar	Hackberry, honeylocust, Austrian pine, eastern white pine, green ash, pin oak.	Eastern cottonwood.
JuC---------------- Judson	---	Lilac, Amur honeysuckle, autumn-olive, Amur maple.	Eastern redcedar, hackberry, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
Ke----------------- Kennebec	---	Amur maple, autumn-olive, Amur honeysuckle, lilac.	Eastern redcedar	Eastern white pine, honeylocust, Austrian pine, pin oak, hackberry, green ash.	Eastern cottonwood.
KnB*: Kennebec----------	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Eastern redcedar	Austrian pine, hackberry, pin oak, green ash, honeylocust.	Eastern white pine, eastern cottonwood.
Nodaway-----------	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
MaD2--------------- Malcolm	Peking cotoneaster, lilac.	Amur honeysuckle, skunkbush sumac.	Eastern redcedar, green ash, bur oak, hackberry, Russian mulberry.	Austrian pine, Scotch pine, honeylocust.	---
McC, McC2, McD2--- Marshall	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
MeC2--------------- Mayberry	Siberian peashrub, Amur honeysuckle, lilac.	Eastern redcedar, Manchurian crabapple, autumn-olive.	Russian-olive, Austrian pine, jack pine, green ash, hackberry, honeylocust.	---	---
MmC2, MmD2--------- Monona	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Bur oak, hackberry, green ash, Russian-olive, eastern redcedar.	Honeylocust, eastern white pine, Austrian pine.	---
MnD2*, MnE2*: Monona------------	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Bur oak, hackberry, green ash, Russian-olive, eastern redcedar.	Honeylocust, eastern white pine, Austrian pine.	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
MnD2*, MnE2*: Ida	Tatarian honeysuckle, fragrant sumac.	Siberian peashrub	Honeylocust, northern catalpa, osageorange, Russian-olive, eastern redcedar, green ash, black locust, bur oak.	Siberian elm	---
MnF2*, MnG*: Monona.					
Ida.					
MpG*: Monona.					
Kipson.					
MrD2 Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, hackberry, Russian-olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Mv Moville	Blackhaw	Siberian peashrub, Tatarian honeysuckle.	Washington hawthorn, Russian-olive, osageorange, eastern redcedar.	Bur oak, green ash, hackberry, honeylocust.	Eastern cottonwood.
Nc Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
Nf. Nodaway					
Ng*: Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
Oc, On Onawa	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Osageorange, eastern redcedar, Russian-olive, Washington hawthorn.	Hackberry, bur oak, green ash, honeylocust.	Eastern cottonwood.
PaC, PbC2 Pawnee	Amur honeysuckle, lilac, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, Manchurian crabapple.	Austrian pine, Russian-olive, green ash, hackberry, honeylocust.	Siberian elm	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Pe*:					
Percival	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Honeylocust, green ash, bur oak, hackberry.	Eastern cottonwood.
Albaton	Blackhaw	Siberian peashrub, Tatarian honeysuckle.	Osageorange, Russian-olive, eastern redcedar, Washington hawthorn.	Hackberry, bur oak, honeylocust, green ash.	Eastern cottonwood.
Pt. Pits					
SaB Sarpy	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, eastern redcedar, osageorange, ponderosa pine.	Hackberry, green ash, honeylocust, bur oak, Austrian pine.	---
SbB*:					
Sarpy	Blackhaw	Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, osageorange, ponderosa pine.	Bur oak, hackberry, green ash, honeylocust, Austrian pine.	---
Haynie	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.
Sh, ShC, ShC2, ShD2 Sharpsburg	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, hackberry, bur oak, eastern redcedar, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
SkD Shelby	---	Autumn-olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
SkF. Shelby					
SvF*:					
Sogn.					
Kipson.					
Ud. Udorthents					
Wc Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
Wd. Wabash					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Wt, WtC, WyC2----- Wymore	Peking cotoneaster, skunkbush sumac, lilac.	Manchurian crabapple, Amur honeysuckle.	Eastern redcedar, Austrian pine, ponderosa pine, Russian-olive, hackberry, green ash.	Honeylocust-------	---
Zh*:					
Zoe--------------	Tatarian honeysuckle, lilac, silver buffaloberry.	Eastern redcedar, Siberian peashrub.	Green ash, Russian-olive.	White willow, golden willow, Siberian elm.	Eastern cottonwood.
Zook-------------	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.
Zk, Zo----------- Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Aa: Ackmore	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Ab: Albaton	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.	Severe: too clayey.
BfD2*:					
Benfield	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: large stones, slope.
Kipson	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones, depth to rock.	Slight	Severe: thin layer.
BfF*:					
Benfield	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
Kipson	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: small stones, depth to rock.	Moderate: slope.	Severe: slope, thin layer.
Bn: Blencoe	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
BrE: Burchard	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Co: Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Gn: Grable	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
GyD2: Gymer	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Hb: Haynie	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Hd: Haynie	Severe: flooding, percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey.
Ju: Judson	Slight	Slight	Slight	Slight	Slight.
JuC: Judson	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Ke---------------------- Kennebec	Severe: flooding.	Slight----------	Slight----------	Slight----------	Slight.
KnB*:					
Kennebec--------------	Severe: flooding.	Slight----------	Moderate: slope, flooding.	Slight----------	Moderate: flooding.
Nodaway---------------	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
MaD2------------------- Malcolm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
McC, McC2------------- Marshall	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
McD2------------------- Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
MeC2------------------- Mayberry	Severe: wetness, too clayey.	Severe: too clayey.	Severe: slope, too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
MmC2------------------- Monona	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
MmD2------------------- Monona	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
MnD2*, MnE2*:					
Monona----------------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
Ida--------------------	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
MnF2*:					
Monona----------------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Ida--------------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
MnG*:					
Monona----------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ida--------------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, erodes easily.	Severe: slope.
MpG*:					
Monona----------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Kipson----------------	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: small stones, depth to rock.	Severe: slope.	Severe: slope, thin layer.
MrD2------------------- Morrill	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Mv------------------ Moville	Severe: flooding, wetness, percs slowly.	Severe: percs slowly.	Severe: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, flooding.
Nc------------------ Nodaway	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
Nf------------------ Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Ng*:					
Nodaway--------------	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
Colo-----------------	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Oc------------------ Onawa	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Slight----------	Moderate: flooding.
On------------------ Onawa	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
PaC----------------- Pawnee	Severe: wetness.	Moderate: wetness.	Severe: slope, wetness.	Severe: erodes easily.	Moderate: wetness.
PbC2---------------- Pawnee	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey, slope, wetness.	Severe: too clayey, erodes easily.	Severe: too clayey.
Pe*:					
Percival-------------	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
Albaton--------------	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.	Severe: too clayey.
Pt. Pits					
SaB----------------- Sarpy	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: droughty, flooding.
SbB*:					
Sarpy----------------	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Haynie---------------	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Sh------------------ Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight----------	Slight.
ShC, ShC2----------- Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight----------	Slight.
ShD2---------------- Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight----------	Moderate: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
SkD: Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
SkF: Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
SvF*:					
Sogn	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Moderate: slope.	Severe: slope, thin layer.
Kipson	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: small stones, depth to rock.	Moderate: slope.	Severe: slope, thin layer.
Ud. Udorthents					
Wc: Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
Wd: Wabash	Severe: flooding, ponding, percs slowly.	Severe: ponding, too clayey, percs slowly.	Severe: too clayey, ponding, flooding.	Severe: ponding, too clayey.	Severe: ponding, flooding, too clayey.
Wt, WtC: Wymore	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
WyC2: Wymore	Severe: wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
Zh*:					
Zoe	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Zk, Zo: Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
Aa------------------ Ackmore	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Ab------------------ Albaton	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
BfD2*:										
Benfield-----------	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Kipson-------------	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
BfF*:										
Benfield-----------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Kipson-------------	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Bn------------------ Blencoe	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
BrE----------------- Burchard	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Co------------------ Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Gn------------------ Grable	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
GyD2---------------- Gymer	Fair	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
Hb------------------ Haynie	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Hd------------------ Haynie	Fair	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
Ju, JuC------------- Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Ke------------------ Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
KnB*:										
Kennebec-----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Nodaway------------	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Fair.
MaD2---------------- Malcolm	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
McC, McC2----------- Marshall	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
McD2---------------- Marshall	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
MeC2----------------- Mayberry	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
MmC2----------------- Monona	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MmD2----------------- Monona	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MnD2*:										
Monona-------------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Ida----------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MnE2*:										
Monona-------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Ida----------------	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
MnF2*:										
Monona-------------	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Ida----------------	Poor	Fair	Good	Poor	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
MnG*:										
Monona-------------	Very poor.	Poor	Good	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Ida----------------	Very poor.	Poor	Good	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
MpG*:										
Monona-------------	Very poor.	Poor	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Kipson-------------	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
MrD2----------------- Morrill	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
Mv------------------- Moville	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
Nc------------------- Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Fair.
Nf------------------- Nodaway	Poor	Fair	Good	Good	Poor	Fair	Fair	Fair	Good	Fair.
Ng*:										
Nodaway------------	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Fair.
Colo---------------	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Oc, On--------------- Onawa	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
PaC, PbC2------------ Pawnee	Fair	Good	Good	Fair	Fair	Very poor.	Poor	Good	Fair	Poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Pe*:										
Percival	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair.
Albaton	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
Pt. Pits										
SaB Sarpy	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
SbB*:										
Sarpy	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Haynie	Poor	Fair	Fair	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
Sh, ShC, ShC2 Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
ShD2 Sharpsburg	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
SkD Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
SkF Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
SvF*:										
Sogn	Very poor.	Very poor.	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
Kipson	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Ud. Udorthents										
Wc Wabash	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Wd Wabash	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Wt Wymore	Good	Good	Fair	Good	Good	Poor	Very poor.	Good	Good	Very poor.
WtC, WyC2 Wymore	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Zh*:										
Zoe	Poor	Fair	Fair	Fair	Fair	Good	Good	Poor	Fair	Good.
Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Zk, Zo Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Aa----------------- Ackmore	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Ab----------------- Albaton	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, shrink-swell.	Severe: too clayey.
BfD2*:						
Benfield---------	Moderate: depth to rock, too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: large stones, slope.
Kipson-----------	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope, low strength.	Severe: thin layer.
BfF*:						
Benfield---------	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
Kipson-----------	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
Bn----------------- Blencoe	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, frost action.	Severe: too clayey.
BrE---------------- Burchard	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Co----------------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Gn----------------- Grable	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
GyD2--------------- Gymer	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Hb----------------- Haynie	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
Hd----------------- Haynie	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action.	Severe: too clayey.
Ju----------------- Judson	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
JuC----------------- Judson	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
Ke------------------ Kennebec	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
KnB*:						
Kennebec-----------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
Nodaway------------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
MaD2--------------- Malcolm	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
McC, McC2---------- Marshall	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
McD2--------------- Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
MeC2--------------- Mayberry	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
MmC2--------------- Monona	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
MmD2--------------- Monona	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
MnD2*, MnE2*:						
Monona------------	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Ida---------------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
MnF2*, MnG*:						
Monona------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
Ida---------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
MpG*:						
Monona------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
MpG*:						
Kipson	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
MrD2 Morrill	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Mv Moville	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Nc Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
Nf Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.
Ng*:						
Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Oc Onawa	Severe: wetness.	Severe: flooding.	Severe: flooding wetness.	Severe: flooding.	Severe: flooding, low strength, frost action.	Moderate: flooding.
On Onawa	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding, low strength, frost action.	Severe: too clayey.
PaC, PbC2 Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.	Severe: wetness, too clayey.
Pe*:						
Percival	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: too clayey.
Albaton	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, shrink-swell.	Severe: too clayey.
Pt. Pits						
SaB Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: droughty, flooding.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
SbB*:						
Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Haynie	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Severe: flooding.
Sh, ShC, ShC2 Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
ShD2 Sharpsburg	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
SkD Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
SkF Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
SvF*:						
Sogn	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, thin layer.
Kipson	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
Ud. Udorthents						
Wc Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.	Severe: wetness, too clayey.
Wd Wabash	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: low strength, ponding, flooding.	Severe: ponding, flooding, too clayey.
Wt, WtC Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
WyC2 Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Severe: too clayey.
Zh*:						
Zoe	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: wetness, flooding, alkali.
Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Zk, Zo Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Aa------------------- Ackmore	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
Ab------------------- Albaton	Severe: flooding, wetness, percs slowly.	Severe: wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
BfD2*:					
Benfield------------	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Kipson--------------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
BfF*:					
Benfield------------	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: area reclaim, too clayey, hard to pack.
Kipson--------------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Bn------------------- Blencoe	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness.	Severe: wetness.	Poor: wetness, thin layer.
BrE------------------ Burchard	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Co------------------- Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
Gn------------------- Grable	Severe: flooding, poor filter.	Severe: seepage.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
GyD2----------------- Gymer	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
Hb------------------- Haynie	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Hd------------------- Haynie	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding.	Poor: thin layer.
Ju------------------- Judson	Slight-----------	Moderate: seepage.	Slight-----------	Slight-----------	Good.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
JuC: Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Ke: Kennebec	Moderate: flooding, wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: flooding, wetness.	Good.
KnB*:					
Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
MaD2: Malcolm	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
McC, McC2: Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
McD2: Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MeC2: Mayberry	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
MmC2: Monona	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
MmD2: Monona	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MnD2*, MnE2*:					
Monona	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ida	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MnF2*, MnG*:					
Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
MpG*:					
Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Kipson	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
MrD2: Morrill	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Mv----------------- Moville	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, wetness, hard to pack.
Nc, Nf------------- Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Ng*:					
Nodaway------------	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Colo---------------	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
Oc, On------------- Onawa	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: wetness, flooding, seepage.	Fair: wetness.
PaC, PbC2---------- Pawnee	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pe*:					
Percival-----------	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy.
Albaton------------	Severe: flooding, wetness, percs slowly.	Severe: wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Pt. Pits					
SaB---------------- Sarpy	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
SbB*:					
Sarpy--------------	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
Haynie-------------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Sh----------------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
ShC, ShC2---------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
ShD2--------------- Sharpsburg	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
SkD----------------- Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
SkF----------------- Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
SvF*:					
Sogn----------------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope.
Kipson--------------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Ud. Udorthents					
Wc------------------ Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Wd------------------ Wabash	Severe: flooding, ponding, percs slowly.	Severe: flooding, ponding.	Severe: flooding, ponding, too clayey.	Severe: flooding, ponding.	Poor: too clayey, hard to pack, ponding.
Wt------------------ Wymore	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
WtC, WyC2----------- Wymore	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Zh*:					
Zoe-----------------	Severe: flooding, wetness, percs slowly.	Severe: wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Zook----------------	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
Zk, Zo-------------- Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Aa: Ackmore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ab: Albaton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
BfD2*:				
Benfield	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
BfF*:				
Benfield	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Bn: Blencoe	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
BrE: Burchard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Co: Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Gn: Grable	Good	Probable	Improbable: too sandy.	Fair: thin layer.
GyD2: Gymer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Hb: Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Hd: Haynie	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, too clayey.
Ju, JuC: Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ke: Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
KnB*:				
Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
MaD2 Malcolm	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
McC, McC2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
McD2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MeC2 Mayberry	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
MmC2 Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
MmD2 Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MnD2*, MnE2*:				
Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Ida	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MnF2*:				
Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ida	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
MnG*:				
Monona	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ida	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
MpG*:				
Monona	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Kipson	Poor: area reclaim, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
MrD2 Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Mv Moville	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nc, Nf Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ng*:				
Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Oc, On Onawa	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
PaC, PbC2 Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Pe*:				
Percival	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too clayey.
Albaton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Pt. Pits				
SaB Sarpy	Good	Probable	Improbable: too sandy.	Poor: too sandy.
SbB*:				
Sarpy	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sh, ShC, ShC2, ShD2 Sharpsburg	Poor: low. strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
SkD Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
SkF Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
SvF*:				
Sogn	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Ud. Udorthents				
Wc, Wd Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Wt, WtC Wymore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
WyC2------------------ Wymore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Zh*:				
Zoe-------------------	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Zook------------------	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Zk-------------------- Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Zo-------------------- Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Aa----------------- Ackmore	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding, frost action.	Wetness---------	Wetness, erodes easily.	Wetness, erodes easily.
Ab----------------- Albaton	Slight----------	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Not needed------	Not needed.
BfD2*, BfF*:						
Benfield----------	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Kipson------------	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Bn----------------- Blencoe	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
BrE---------------- Burchard	Severe: slope.	Slight----------	Deep to water	Slope-----------	Slope-----------	Slope.
Co----------------- Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness---------	Wetness.
Gn----------------- Grable	Severe: seepage.	Severe: seepage, piping.	Deep to water	Flooding--------	Erodes easily, too sandy.	Erodes easily.
GyD2--------------- Gymer	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.
Hb----------------- Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily, flooding.	Erodes easily	Erodes easily.
Hd----------------- Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Rooting depth	Erodes easily	Erodes easily, rooting depth, percs slowly.
Ju----------------- Judson	Moderate: seepage.	Severe: piping.	Deep to water	Favorable-------	Erodes easily	Erodes easily.
JuC---------------- Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope-----------	Erodes easily	Erodes easily.
Ke----------------- Kennebec	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable-------	Favorable-------	Favorable.
KnB*:						
Kennebec----------	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding--------	Favorable-------	Favorable.
Nodaway-----------	Moderate: seepage.	Severe: piping.	Deep to water	Flooding--------	Erodes easily	Erodes easily.
MaD2--------------- Malcolm	Severe: slope.	Severe: piping.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
McC, McC2: Marshall	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
McD2: Marshall	Severe: slope.	Slight	Deep to water	Slope	Erodes easily, slope.	Slope, erodes easily.
MeC2: Mayberry	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
MmC2: Monona	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
MmD2: Monona	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
MnD2*, MnE2*, MnF2*, MnG*:						
Monona	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Ida	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
MpG*:						
Monona	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Kipson	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
MrD2: Morrill	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope	Slope.
Mv: Moville	Slight	Severe: wetness, hard to pack.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, percs slowly.
Nc, Nf: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Ng*:						
Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
Oc: Onawa	Severe: seepage.	Severe: piping.	Flooding, frost action, percs slowly.	Wetness, flooding, percs slowly.	Not needed	Not needed.
On: Onawa	Severe: seepage.	Severe: piping.	Flooding, frost action, percs slowly.	Wetness, slow intake, percs slowly.	Not needed	Not needed.
PaC, PbC2: Pawnee	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
Pe*:						
Percival	Severe: seepage.	Severe: seepage, piping.	Percs slowly, flooding, cutbanks cave.	Wetness, droughty, slow intake.	Wetness, too sandy.	Droughty, percs slowly.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Pe*:						
Albaton	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Not needed	Not needed.
Pt. Pits						
SaB Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
SbB*:						
Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily, flooding.	Erodes easily	Erodes easily.
Sh Sharpsburg	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
ShC, ShC2 Sharpsburg	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
ShD2 Sharpsburg	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
SkD, SkF Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
SvF*:						
Sogn	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Kipson	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Ud. Udorthents						
Wc Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Wd Wabash	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, flooding.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
Wt Wymore	Slight	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
WtC Wymore	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
WyC2 Wymore	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
Zh*:						
Zoe	Slight	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, percs slowly.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Zh*:						
Zook-------------	Slight---------	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed-----	Not needed.
Zk, Zo------------ Zook	Slight---------	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed-----	Not needed.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Aa---------------- Ackmore	0-19	Silt loam--------	CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	8-20
	19-60	Silty clay loam, silt loam.	CH, CL, MH, ML	A-7, A-6	0	100	100	95-100	85-100	35-60	15-30
Ab---------------- Albaton	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	8-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
BfD2*, BfF*: Benfield---------	0-8	Silty clay loam	CL	A-6, A-7	0-15	85-100	85-100	85-95	85-95	30-50	11-25
	8-26	Silty clay, silty clay loam, silty clay.	CH, CL	A-7-6	0-15	85-100	70-100	70-95	70-95	40-60	20-35
	26-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Kipson-----------	0-7	Silty clay loam	CL, ML, MH, CH	A-6, A-7	0-25	80-100	70-100	65-100	60-95	35-55	10-20
	7-15	Shaly silt loam, shaly silty clay loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	15-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Bn---------------- Blencoe	0-22	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	30-50
	22-41	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	41-60	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	30-50
BrE--------------- Burchard	0-13	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	14-24
	13-42	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	42-60	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	35-50	15-30
Co---------------- Colo	0-30	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	30-36	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	36-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Gn---------------- Grable	0-8	Very fine sandy loam.	CL	A-4, A-6	0	100	100	80-95	50-75	25-40	8-20
	8-20	Silt loam, very fine sandy loam.	CL	A-4, A-6	0	100	100	80-95	50-75	25-40	8-20
	20-60	Fine sand, loamy sand, sand.	SM, SM-SC, SP-SM	A-2, A-3	0	100	100	65-80	5-35	<20	NP-5
GyD2-------------- Gymer	0-6	Silty clay loam	CL, ML	A-4, A-6	0	100	100	95-100	75-100	25-40	8-20
	6-60	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	15-30
Hb---------------- Haynie	0-8	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	8-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15
Hd---------------- Haynie	0-12	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	60-80	35-50
	12-48	Stratified silt loam to very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	65-95	20-30	5-15
	48-60	Loamy very fine sand, fine sand.	SM	A-2, A-4	0	100	100	70-95	30-50	<20	NP
Ju, JuC----------- Judson	0-17	Silt loam--------	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	17-41	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	41-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ke---------------- Kennebec	0-40	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	40-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
KnB*: Kennebec---------	0-24	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	24-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
Nodaway----------	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
MaD2-------------- Malcolm	0-8	Silt loam--------	CL	A-4, A-6	0	100	100	90-100	70-90	25-35	7-17
	8-22	Silty clay loam, silt loam.	CL	A-6	0	100	100	90-100	70-95	25-40	10-20
	22-60	Silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	55-100	20-35	3-15
McC--------------- Marshall	0-13	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	13-44	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	44-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
McC2, McD2-------- Marshall	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	7-32	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	32-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
MeC2-------------- Mayberry	0-7	Clay-------------	CH, CL	A-7	0	100	100	90-100	90-100	45-60	25-35
	7-26	Clay, sandy clay	CL, CH	A-7	0	100	90-100	80-100	60-100	45-60	25-35
	26-60	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	85-95	70-95	35-60	15-30
MmC2, MmD2-------- Monona	0-7	Silt loam--------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	7-39	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	39-60	Silt loam--------	CL, ML	A-6	0	100	100	95-100	95-100	30-40	10-20
MnD2*, MnE2*, MnF2*: Monona----------	0-6	Silt loam--------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	6-27	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	27-60	Silt loam--------	CL, ML	A-6	0	100	100	95-100	95-100	30-40	10-20
Ida--------------	0-60	Silt loam--------	ML, CL	A-4, A-6	0	100	100	95-100	95-100	30-40	5-15
MnG*: Monona-----------	0-10	Silt loam--------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	10-45	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	45-60	Silt loam--------	CL, ML	A-6	0	100	100	95-100	95-100	30-40	10-20
Ida--------------	0-60	Silt loam--------	ML, CL	A-4, A-6	0	100	100	95-100	95-100	30-40	5-15
MpG*: Monona-----------	0-10	Silt loam--------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	10-39	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	39-60	Silt loam--------	CL, ML	A-6	0	100	100	95-100	95-100	30-40	10-20
Kipson-----------	0-6	Silty clay loam	CL, ML, MH, CH	A-6, A-7	0-25	80-100	70-100	65-100	60-95	35-55	10-20
	6-12	Shaly silt loam, silt loam, silty clay loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	12-60	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
MrD2------------- Morrill	0-9	Clay loam--------	CL	A-4, A-6	0	95-100	80-100	70-100	50-75	25-35	7-15
	9-33	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	30-45	11-25
	33-60	Loam, clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	60-100	30-80	20-35	2-15
Mv--------------- Moville	0-28	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	90-100	30-40	8-18
	28-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	65-85	40-60
Nc, Nf----------- Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
Ng*:											
Nodaway---------	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
Colo------------	0-20	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	20-30	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	30-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Oc--------------- Onawa	0-10	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	80-100	25-40	5-20
	10-20	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	20-60	Silt loam, very fine sandy loam, loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
On--------------- Onawa	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	8-20	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	20-51	Silt loam, very fine sandy loam, loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	51-60	Fine sand--------	SM, SM-SC, SP-SM	A-2, A-3	0	100	100	65-80	5-35	<20	NP-5
PaC-------------- Pawnee	0-19	Clay loam--------	CL	A-6	0	95-100	95-100	85-100	70-90	30-40	10-20
	19-48	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	48-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
PbC2------------- Pawnee	0-5	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	5-40	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	40-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
Pe*:											
Percival--------	0-6	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	35-60
	6-23	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	35-60
	23-60	Stratified fine sand to loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	100	80-95	12-30	<20	NP-5
Albaton---------	0-6	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	6-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
Pt. Pits											
SaB-------------- Sarpy	0-6	Loamy fine sand	SM	A-2-4	0	100	100	60-80	15-35	---	NP
	6-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
SbB*:											
Sarpy-----------	0-7	Loamy sand-------	SM	A-2-4	0	100	100	60-80	15-35	---	NP
	7-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
Haynie----------	0-7	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	7-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Sh, ShC----------- Sharpsburg	0-18	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	18-40	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	40-49	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	49-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
ShC2, ShD2-------- Sharpsburg	0-8	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	8-21	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	21-32	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	32-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
SkD, SkF---------- Shelby	0-17	Clay loam---------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	17-42	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	42-60	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
SvF*:											
Sogn-------------	0-8	Loam--------------	CL	A-6	0-10	85-100	85-100	85-100	70-95	25-40	11-23
	8-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Kipson-----------	0-10	Silty clay loam	CL, ML, MH, CH	A-6, A-7	0-25	80-100	70-100	65-100	60-95	35-55	10-20
	10-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ud. Udorthents											
Wc---------------- Wabash	0-9	Silty clay--------	CH	A-7	0	100	100	100	95-100	50-75	30-50
	9-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
Wd---------------- Wabash	0-11	Silty clay--------	CH	A-7	0	100	100	95-100	90-100	50-75	30-50
	11-60	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	50-75	30-55
Wt, WtC----------- Wymore	0-10	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	95-100	95-100	35-55	11-25
	10-30	Silty clay--------	CH	A-7	0	100	100	95-100	90-100	55-70	30-42
	30-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
WyC2-------------- Wymore	0-7	Silty clay--------	CL, CH	A-7	0	100	100	95-100	95-100	45-55	15-26
	7-35	Silty clay--------	CH	A-7	0	100	100	95-100	90-100	55-70	30-42
	35-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
Zh*:											
Zoe--------------	0-12	Silty clay loam	CL	A-6, A-7, A-4	0	100	100	90-100	70-95	25-45	8-25
	12-34	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	85-95	35-60	15-35
	34-60	Silty clay--------	CH	A-7	0	100	100	95-100	90-95	50-70	25-40
Zook-------------	0-8	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	8-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
Zk---------------- Zook	0-19	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	19-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
Zo---------------- Zook	0-21	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	21-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cm^3	In/hr	In/in	pH	mmhos/cm					Pct
Aa---------------- Ackmore	0-19	25-30	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.37	5	6	2-4
	19-60	26-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.8	<2	High------	0.37			
Ab---------------- Albaton	0-8	40-60	1.35-1.40	<0.2	0.11-0.13	7.4-8.4	<2	High------	0.28	5	4	2-3
	8-60	50-60	1.35-1.45	<0.06	0.11-0.13	7.4-8.4	<2	High------	0.28			
BfD2*, BfF*:												
Benfield---------	0-8	20-35	1.30-1.40	0.2-2.0	0.21-0.24	6.1-7.8	<2	Moderate	0.37	3	7	2-4
	8-26	35-45	1.35-1.45	0.06-0.2	0.18-0.22	6.6-8.4	<2	High------	0.37			
	26-60	---	---	---	---	---	---	----------	----			
Kipson-----------	0-7	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32	2	4L	2-4
	7-15	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	<2	Moderate	0.32			
	15-60	---	---	---	---	---	---	----------	----			
Bn---------------- Blencoe	0-22	40-55	1.40-1.50	0.06-0.2	0.12-0.14	6.1-7.3	<2	High------	0.28	5	4	2-4
	22-41	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate	0.43			
	41-60	40-55	1.40-1.50	<0.06	0.10-0.13	7.4-8.4	<2	High------	0.32			
BrE--------------- Burchard	0-13	27-35	1.40-1.60	0.2-0.6	0.17-0.19	5.6-7.3	<2	Moderate	0.28	5	6	2-4
	13-42	27-35	1.40-1.60	0.2-0.6	0.15-0.17	6.1-8.4	<2	Moderate	0.37			
	42-60	27-35	1.40-1.60	0.2-0.6	0.14-0.16	7.4-8.4	<2	Moderate	0.37			
Co---------------- Colo	0-30	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	<2	High------	0.28	5	7	5-7
	30-36	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	High------	0.28			
	36-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	<2	High------	0.28			
Gn---------------- Grable	0-8	18-27	1.20-1.25	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low-------	0.32	4	4L	.5-1
	8-20	12-16	1.25-1.50	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	0.43			
	20-60	2-10	1.20-1.50	6.0-20	0.02-0.07	7.4-8.4	<2	Low-------	0.15			
GyD2-------------- Gymer	0-6	20-35	1.30-1.40	0.6-2.0	0.22-0.24	5.1-6.5	<2	Low-------	0.32	5	6	2-4
	6-60	35-42	1.40-1.50	0.2-0.6	0.12-0.20	5.6-6.5	<2	Moderate	0.43			
Hb---------------- Haynie	0-8	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37	5	4L	2-3
	8-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37			
Hd---------------- Haynie	0-12	40-60	1.25-1.45	<0.2	0.13-0.15	7.4-8.4	<2	High------	0.28	5	4	2-3
	12-48	15-25	1.40-1.60	0.6-2.0	0.17-0.22	7.9-8.4	<2	Low-------	0.43			
	48-60	3-5	2.10-2.20	2.0-6.0	0.12-0.14	7.9-8.4	<2	Low-------	0.24			
Ju, JuC----------- Judson	0-17	25-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.28	5	6	4-5
	17-41	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.43			
	41-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	<2	Moderate	0.43			
Ke---------------- Kennebec	0-40	26-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	5-6
	40-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
KnB*:												
Kennebec---------	0-24	22-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	5-6
	24-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
Nodaway----------	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
MaD2-------------- Malcolm	0-8	17-23	1.20-1.30	0.6-2.0	0.22-0.24	5.6-6.5	<2	Low-------	0.32	5	5	1-2
	8-22	24-35	1.30-1.40	0.6-2.0	0.18-0.22	5.6-6.5	<2	Moderate	0.43			
	22-60	12-23	1.20-1.30	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low-------	0.43			
McC--------------- Marshall	0-13	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.32	5	7	3-4
	13-44	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.43			
	44-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	<2	Moderate	0.43			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cm3	In/hr	In/in	pH	mmhos/cm					Pct
McC2, McD2-------- Marshall	0-7	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.32	5	7	3-4
	7-32	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.43			
	32-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	<2	Moderate	0.43			
MeC2------------- Mayberry	0-7	40-46	1.40-1.50	0.06-0.2	0.12-0.14	5.6-6.5	<2	High------	0.37	3	4	1-2
	7-26	40-50	1.50-1.70	0.06-0.2	0.10-0.11	5.6-7.3	<2	High------	0.37			
	26-60	18-45	1.40-1.50	0.06-0.2	0.09-0.16	5.6-7.3	<2	Moderate	0.37			
MmC2, MmD2-------- Monona	0-7	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
	7-39	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	39-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			
MnD2*, MnE2*, MnF2*:												
Monona----------	0-6	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
	6-27	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	27-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			
Ida-------------	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low--------	0.43	5	4L	.5-1
MnG*:												
Monona-----------	0-10	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
	10-45	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	45-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			
Ida--------------	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low--------	0.43	5	4L	.5-1
MpG*:												
Monona-----------	0-10	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
	10-39	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	39-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			
Kipson-----------	0-6	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32	2	4L	2-4
	6-12	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	<2	Moderate	0.32			
	12-60	---	---	---	---	---	---	-----------	-----			
MrD2------------- Morrill	0-9	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	<2	Low--------	0.28	5	6	2-4
	9-33	25-35	1.35-1.45	0.6-2.0	0.15-0.19	5.1-7.3	<2	Moderate	0.28			
	33-60	10-29	1.40-1.55	0.6-2.0	0.15-0.18	5.1-7.3	<2	Low--------	0.37			
Mv--------------- Moville	0-28	10-18	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	<2	Low--------	0.32	5	4L	2-3
	28-60	50-60	1.35-1.45	<0.06	0.11-0.13	6.6-7.8	<2	High------	0.32			
Nc, Nf----------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
Ng*:												
Nodaway----------	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
Colo-------------	0-20	20-26	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.28	5	6	4-6
	20-30	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	High------	0.28			
	30-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	<2	High------	0.28			
Oc--------------- Onawa	0-10	15-22	1.20-1.25	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.32	5	4L	2-3
	10-20	50-60	1.30-1.40	0.06-0.2	0.12-0.14	7.4-8.4	<2	High------	0.32			
	20-60	12-18	1.40-1.50	0.6-6.0	0.20-0.22	7.4-8.4	<2	Low--------	0.43			
On--------------- Onawa	0-8	38-55	1.30-1.35	0.2-0.6	0.12-0.14	7.4-8.4	<2	High------	0.32	5	4	2-3
	8-20	50-60	1.30-1.40	0.06-0.2	0.12-0.14	7.4-8.4	<2	High------	0.32			
	20-51	12-18	1.40-1.50	0.6-6.0	0.20-0.22	7.4-8.4	<2	Low--------	0.43			
	51-60	2-10	1.20-1.50	6.0-20	0.02-0.07	7.4-8.4	<2	Low--------	0.15			
PaC-------------- Pawnee	0-19	30-38	1.40-1.50	0.2-0.6	0.17-0.19	5.6-7.3	<2	Moderate	0.37	4	6	3-4
	19-48	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-8.4	<2	High------	0.37			
	48-60	25-35	1.40-1.50	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
PbC2------------- Pawnee	0-5	40-46	1.40-1.50	0.06-0.2	0.09-0.11	5.6-7.3	<2	High------	0.37	3	4	2-3
	5-40	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-8.4	<2	High------	0.37			
	40-60	25-35	1.40-1.50	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cm3	In/hr	In/in	pH	mmhos/cm					Pct
Pe*:												
Percival--------	0-6	40-60	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	<2	High------	0.28	4	4	2-3
	6-23	40-60	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	<2	High------	0.28			
	23-60	2-12	1.30-1.50	6.0-20	0.06-0.08	7.4-8.4	<2	Low-------	0.15			
Albaton---------	0-6	40-60	1.35-1.40	<0.2	0.11-0.13	7.4-8.4	<2	High------	0.28	5	4	2-3
	6-60	50-60	1.35-1.45	<0.06	0.11-0.13	7.4-8.4	<2	High------	0.28			
Pt. Pits												
SaB--------------- Sarpy	0-6	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.17	5	2	<1
	6-60	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.15			
SbB*:												
Sarpy-----------	0-7	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.17	5	2	<1
	7-60	2-5	1.20-1.50	>6.0	0.05-0.09	7.4-8.4	<2	Low-------	0.15			
Haynie----------	0-7	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37	5	4L	2-3
	7-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37			
Sh, ShC----------- Sharpsburg	0-18	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	3-4
	18-40	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	<2	Moderate	0.43			
	40-49	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	49-60	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
ShC2, ShD2------- Sharpsburg	0-8	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	3-4
	8-21	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	<2	Moderate	0.43			
	21-32	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	32-60	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
SkD, SkF--------- Shelby	0-17	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	<2	Moderate	0.28	5	6	2-3
	17-42	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	<2	Moderate	0.28			
	42-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	<2	Moderate	0.37			
SvF*:												
Sogn------------	0-8	18-25	1.15-1.20	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	1	4L	2-4
	8-60	---	---	---	---	---	---	----------	----			
Kipson----------	0-10	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32	2	4L	2-4
	10-60	---	---	---	---	---	---	----------	----			
Ud. Udorthents												
Wc--------------- Wabash	0-9	40-46	1.25-1.45	<0.06	0.12-0.14	5.6-7.3	<2	Very high	0.28	5	4	2-4
	9-60	40-60	1.20-1.45	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Wd--------------- Wabash	0-11	40-55	1.20-1.30	<0.06	0.13-0.15	5.6-7.3	<2	High------	0.28	5	4	2-4
	11-60	40-55	1.20-1.30	<0.06	0.10-0.14	5.6-7.3	<2	High------	0.28			
Wt, WtC---------- Wymore	0-10	30-40	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	7	2-4
	10-30	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	<2	High------	0.37			
	30-60	27-40	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.3	<2	High------	0.37			
WyC2------------- Wymore	0-7	40-45	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	<2	High------	0.37	4	4	2-4
	7-35	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	<2	High------	0.37			
	35-60	27-40	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.3	<2	High------	0.37			
Zh*:												
Zoe-------------	0-12	34-40	1.10-1.30	0.2-0.6	0.17-0.23	6.1-7.8	<4	Moderate	0.32	5	4	1-2
	12-34	36-45	1.20-1.30	0.06-0.6	0.11-0.20	6.1-7.8	4-8	High------	0.32			
	34-60	40-50	1.20-1.30	0.06-0.2	0.10-0.13	7.4-9.0	2-4	High------	0.32			
Zook------------	0-8	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	<2	High------	0.28	5	7	5-7
	8-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High------	0.28			
Zk--------------- Zook	0-19	20-26	1.30-1.35	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.28	5	6	5-7
	19-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High------	0.28			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors		Wind erodi- bility group	Organic matter
									K	T		
	In	Pct	g/cm^3	In/hr	In/in	pH	mmhos/cm					Pct
Zo---------------- Zook	0-21	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	<2	High------	0.28	5	7	5-7
	21-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Aa: Ackmore	B	Occasional	Very brief to brief.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Low.
Ab: Albaton	D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	Moderate	High	Low.
BfD2*, BfF*:												
Benfield	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	Low.
Kipson	D	None	---	---	>6.0	---	---	7-20	Soft	Moderate	Low	Low.
Bn: Blencoe	D	Rare	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Low.
BrE: Burchard	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Co: Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
Gn: Grable	B	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	Low	Low	Low.
GyD2: Gymer	C	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Hb, Hd: Haynie	B	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	High	Low	Low.
Ju, JuC: Judson	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Low.
Ke: Kennebec	B	Rare	---	---	4.0-6.0	Apparent	Nov-Jul	>60	---	High	Moderate	Low.
KnB*:												
Kennebec	B	Occasional	Brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	High	Moderate	Low.
Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.
MaD2: Malcolm	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
McC, McC2, McD2: Marshall	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
MeC2: Mayberry	D	None	---	---	1.0-3.0	Perched	Mar-May	>60	---	High	High	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
MmC2, MmD2-------- Monona	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low-------	Low.
MnD2*, MnE2*, MnF2*, MnG*:												
Monona----------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Ida------------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
MpG*:												
Monona----------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Kipson----------	D	None--------	---	---	>6.0	---	---	7-20	Soft	Moderate	Low------	Low.
MrD2------------- Morrill	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Mv--------------- Moville	C	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
Nc--------------- Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
Nf--------------- Nodaway	B	Frequent----	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
Ng*:												
Nodaway----------	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
Colo------------	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
Oc, On----------- Onawa	D	Occasional	Brief-----	Feb-Nov	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
PaC, PbC2-------- Pawnee	D	None--------	---	---	1.0-3.0	Perched	Mar-May	>60	---	High-----	High-----	Low.
Pe*:												
Percival---------	C	Occasional	Very brief	Feb-Nov	2.0-4.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Low.
Albaton----------	D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Low.
Pt. Pits												
SaB-------------- Sarpy	A	Occasional	Brief to long.	Feb-Nov	>6.0	---	---	>60	---	Low------	Low------	Low.
SbB*:												
Sarpy------------	A	Frequent----	Brief to long.	Feb-Nov	>6.0	---	---	>60	---	Low------	Low------	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
SbB*:												
Haynie	B	Frequent	Very brief	Feb-Nov	>6.0	---	---	>60	---	High	Low	Low.
Sh, ShC, ShC2, ShD2 Sharpsburg	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
SkD, SkF Shelby	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
SvF*:												
Sogn	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low	Low.
Kipson	D	None	---	---	>6.0	---	---	7-20	Soft	Moderate	Low	Low.
Ud. Udorthents												
Wc Wabash	D	Occasional	Brief to long.	Feb-Nov	1.0-2.0	Apparent	Nov-May	>60	---	Moderate	High	Moderate.
Wd Wabash	D	Frequent	Long	Feb-Nov	+.5-1.0	Apparent	Nov-May	>60	---	High	High	Moderate.
Wt, WtC, WyC2 Wymore	D	None	---	---	1.0-3.0	Perched	Mar-Apr	>60	---	High	High	Moderate.
Zh*:												
Zoe	D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High	High	High.
Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High	High	Moderate.
Zk, Zo Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High	High	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--ENGINEERING INDEX TEST DATA

[Dashes indicate that data were not available. LL means liquid limit, and PI means plasticity index]

Soil name*, report number, horizon, and depth in inches	Classification		Grain-size distribution									LL	PI	Specific gravity
			Percentage passing sieve--						Percentage smaller than--					
	AASHTO	Unified	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm			
												Pct		g/cc
Monona silt loam: (S80NE-127-24)														
Ap------ 0 to 7	A-6(9)	CL	---	---	---	---	100	99	93	26	20	36	12	2.67
Bw------12 to 24	A-6(10)	ML	---	---	---	---	100	99	96	28	21	40	14	2.70
C-------39 to 60	A-6(9)	ML	---	---	---	---	---	100	95	23	21	37	12	2.69
Sharpsburg silty clay loam: (S79NE-127-45)														
Bt2-----24 to 32	A-7-6 (21)	CH	---	---	---	---	---	100	99	47	38	59	33	2.71
C-------49 to 60	A-7-6 (17)	CL	---	---	---	---	100	99	94	39	31	49	27	2.72
Wabash silty clay: (S79NE-127-8)														
Bg2-----32 to 60	A-7-6 (31)	CH	---	---	---	---	---	---	100	67	55	75	49	2.67
Wymore silty clay: (S80NE-127-10)														
Ap------ 0 to 7	A-7-6 (17)	CH	---	---	---	---	100	96	95	49	42	52	26	2.67
Bt2-----13 to 26	A-7-6 (20)	CH	---	---	---	---	100	93	92	49	43	56	32	2.73
C-------42 to 60	A-7-6 (19)	CH	---	---	---	---	---	100	99	42	32	53	31	2.72

* Locations of the sampled pedons are as follows:

Monona silt loam: 1,400 feet north and 500 feet east of the center of sec. 33, T. 4 N., R. 16 E.

Sharpsburg silty clay loam: 150 feet south and 60 feet west of the northeast corner of sec. 17, T. 5 N., R. 14 E.

Wabash silty clay: 250 feet south and 100 feet east of the northwest corner of sec. 24, T. 6 N., R. 13 E.

Wymore silty clay: 1,450 feet north and 170 feet west of the southeast corner of sec. 27, T. 5 N., R. 12 E.

TABLE 19.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Ackmore	Fine-silty, mixed, nonacid, mesic Aeric Fluvaquents
*Albaton	Fine, montmorillonitic (calcareous), mesic Vertic Fluvaquents
*Benfield	Fine, mixed, mesic Udic Argiustolls
Blencoe	Clayey over loamy, montmorillonitic, mesic Aquic Hapludolls
Burchard	Fine-loamy, mixed, mesic Typic Argiudolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Grable	Coarse-silty over sandy or sandy-skeletal, mixed (calcareous), mesic Mollic Udifluvents
*Gymer	Fine, montmorillonitic, mesic Typic Argiudolls
Haynie	Coarse-silty, mixed (calcareous), mesic Mollic Udifluvents
Ida	Fine-silty, mixed (calcareous), mesic Typic Udorthents
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
*Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Malcolm	Fine-silty, mixed, mesic Typic Argiudolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
*Mayberry	Fine, montmorillonitic, mesic Aquic Argiudolls
*Monona	Fine-silty, mixed, mesic Typic Hapludolls
*Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Moville	Coarse-silty over clayey, mixed (calcareous), mesic Aeric Fluvaquents
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Onawa	Clayey over loamy, montmorillonitic (calcareous), mesic Mollic Fluvaquents
Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Percival	Clayey over sandy or sandy-skeletal, montmorillonitic (calcareous), mesic Aquic Udifluvents
Sarpy	Mixed, mesic Typic Udipsamments
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Udorthents	Silty, mixed, nonacid, mesic Udorthents
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Wymore	Fine, montmorillonitic, mesic Aquic Argiudolls
Zoe	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

Interpretive Groups

INTERPRETIVE GROUPS

[Dashes indicate that the soil was not assigned to the interpretive group]

Soil name and map symbol	Land capability*		Prime farmland*	Windbreak suitability group
	N	I		
Aa------------------------- Ackmore	IIw	IIw	Yes**	2S
Ab------------------------- Albaton	IIIw	IIIw	---	2W
BfD2-----------------------	IVe	---	---	
Benfield-------------------				4L
Kipson---------------------				10
BfF------------------------ Benfield-Kipson	VIe	---	---	10
Bn------------------------- Blencoe	IIw	IIw	Yes	2S
BrE------------------------ Burchard	IVe	---	---	3
Co------------------------- Colo	IIw	IIw	Yes**	2S
Gn------------------------- Grable	IIs	I	Yes	1
GyD2----------------------- Gymer	IVe	---	---	4L
Hb------------------------- Haynie	IIw	IIw	Yes	1L
Hd------------------------- Haynie	IIw	IIw	Yes	1L
Ju------------------------- Judson	I	I	Yes	1
JuC------------------------ Judson	IIe	IIIe	Yes	3
Ke------------------------- Kennebec	I	I	Yes	1
KnB------------------------ Kennebec-Nodaway	IIw	IIw	Yes	1
MaD2----------------------- Malcolm	IVe	---	---	3
McC------------------------ Marshall	IIe	IIIe	Yes	3
McC2----------------------- Marshall	IIe	IIIe	Yes	3
McD2----------------------- Marshall	IIIe	IVe	---	3
MeC2----------------------- Mayberry	IVe	---	---	4C
MmC2----------------------- Monona	IIe	IIIe	Yes	3

See footnotes at end of table.

INTERPRETIVE GROUPS--Continued

Soil name and map symbol	Land capability*		Prime farmland*	Windbreak suitability group
	N	I		
MmD2----------------------- Monona	IIIe	IVe	---	3
MnD2----------------------- Monona--------------------- Ida------------------------	IIIe	IVe	---	 3 8
MnE2----------------------- Monona--------------------- Ida------------------------	IVe	---	---	 3 8
MnF2----------------------- Monona-Ida	VIe	---	---	10
MnG------------------------ Monona-Ida	VIIe	---	---	10
MpG------------------------ Monona-Kipson	VIIe	---	---	10
MrD2----------------------- Morrill	IVe	---	---	3
Mv------------------------- Moville	IIw	IIw	Yes**	2S
Nc------------------------- Nodaway	IIw	IIw	Yes	1
Nf------------------------- Nodaway	VIw	---	---	10
Ng------------------------- Nodaway-------------------- Colo-----------------------	IIw	IIw	 Yes Yes**	 1 2S
Oc------------------------- Onawa	IIw	IIw	Yes**	2S
On------------------------- Onawa	IIw	IIw	Yes**	2S
PaC------------------------ Pawnee	IIIe	---	---	4C
PbC2----------------------- Pawnee	IVe	---	---	4C
Pe------------------------- Percival------------------- Albaton--------------------	IIIw	IIIw	---	 2S 2W
Pt------------------------- Pits	VIIIs	---	---	10
SaB------------------------ Sarpy	IVs	IIIs	---	7
SbB------------------------ Sarpy---------------------- Haynie---------------------	IVs	---	---	 7 1L
Sh------------------------- Sharpsburg	I	I	Yes	3
ShC------------------------ Sharpsburg	IIe	IIIe	Yes	3

See footnotes at end of table.

INTERPRETIVE GROUPS--Continued

Soil name and map symbol	Land capability*		Prime farmland*	Windbreak suitability group
	N	I		
ShC2: Sharpsburg	IIe	IIIe	Yes	3
ShD2: Sharpsburg	IIIe	IVe	---	3
SkD: Shelby	IIIe	---	---	3
SkF: Shelby	VIe	---	---	10
SvF: Sogn-Kipson	VIs	---	---	10
Ud: Udorthents	VIs	---	---	10
Wc: Wabash	IIIw	IIIw	---	2W
Wd: Wabash	Vw	---	---	10
Wt: Wymore	IIs	IIs	Yes	4L
WtC: Wymore	IIIe	---	Yes	4L
WyC2: Wymore	IIIe	---	Yes	4L
Zh:	IVs	---	---	
Zoe				9S
Zook				2W
Zk: Zook	IIw	IIw	Yes**	2W
Zo: Zook	IIw	IIw	Yes**	2W

* A soil complex is treated as a single management unit in the land capability classification and prime farmland columns. The N column is for nonirrigated soils; the I column is for irrigated soils.
** Where drained.

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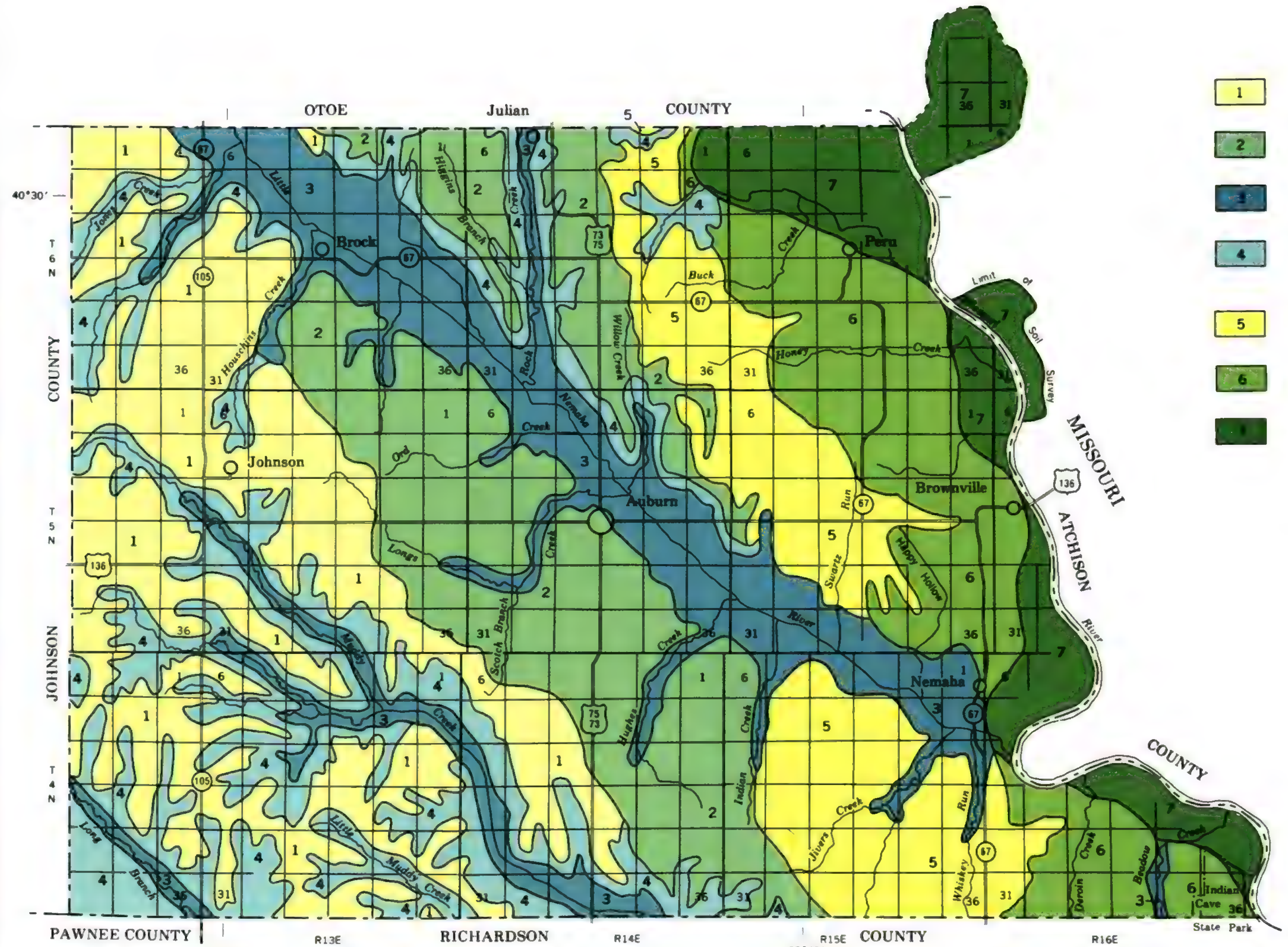


SOIL LEGEND*

1	WYMORE association: Deep, nearly level to gently sloping, moderately well drained, clayey and silty soils formed in loess; on uplands
2	SHARPSBURG association: Deep, nearly level to strongly sloping, moderately well drained, silty soils formed in loess; on uplands
3	NODAWAY-ZOOK-ACKMORE association: Deep, nearly level and very gently sloping, moderately well drained to poorly drained, silty soils formed in alluvium; on bottom land
4	PAWNEE-NODAWAY-GYMER association: Deep, nearly level to strongly sloping, moderately well drained and well drained, clayey, loamy, and silty soils formed in glacial till, alluvium, and loess; on uplands and bottom land
5	MARSHALL association: Deep, gently sloping and strongly sloping, well drained, silty soils formed in loess; on uplands
6	MONONA-IDA association: Deep, gently sloping to very steep, well drained, silty soils formed in loess; on uplands
7	ONAWA-HAYNIE-ALBATON association: Deep, nearly level, somewhat poorly drained, moderately well drained, and poorly drained, clayey and silty soils formed in alluvium; on bottom land

*The texture terms in the descriptive headings refer to the texture of the surface layer of the major soils in each association.

Compiled 1984

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF NEBRASKA
CONSERVATION AND SURVEY DIVISION

GENERAL SOIL MAP

NEMAHA COUNTY, NEBRASKA

Scale 1:190,080

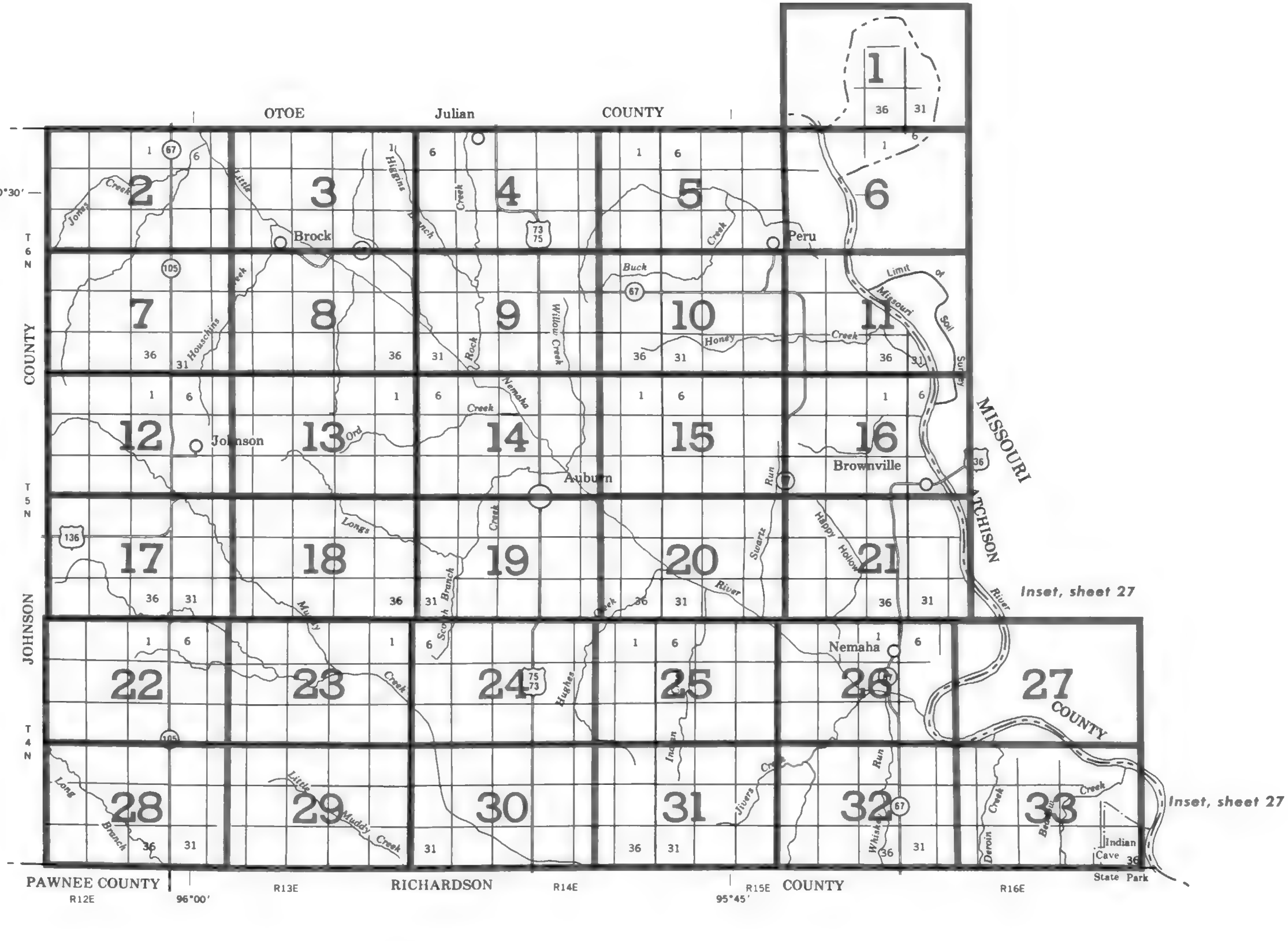
1 0 1 2 3 Miles

1 0 3 6 Km

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

NEMAHA COUNTY, NEBRASKA

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

SOIL LEGEND

Map symbols consist of a combination of letters or of letters and a number. The first capital letter is the initial one of the map unit name. The lower case letter that follows separates map units having names that begin with the same letter, except that it does not separate sloping or eroded phases. The second capital letter indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 indicates that the soil is eroded.

SYMBOL	NAME
Aa	Ackmore silt loam, 0 to 1 percent slopes
Ab	Albaton silty clay, 0 to 1 percent slopes
BfD2	Benfield-Kipson silty clay loams, 6 to 11 percent slopes, eroded
BfF	Benfield-Kipson silty clay loams, 11 to 30 percent slopes
Bn	Blencoe silty clay, clayey substratum, 0 to 2 percent slopes
BrE	Burchard clay loam, 11 to 15 percent slopes
Co	Colo silty clay loam, 0 to 1 percent slopes
Gn	Grable very fine sandy loam, 0 to 2 percent slopes
GyD2	Gymer silty clay loam, 5 to 11 percent slopes, eroded
Hb	Haynie silt loam, 0 to 2 percent slopes
Hd	Haynie silty clay, overwash, 0 to 2 percent slopes
Ju	Judson silt loam, 0 to 2 percent slopes
JuC	Judson silt loam, 2 to 6 percent slopes
Ke	Kennebec silt loam, 0 to 1 percent slopes
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes
MaD2	Malcolm silt loam, 5 to 11 percent slopes, eroded
McC	Marshall silty clay loam, 2 to 5 percent slopes
McC2	Marshall silty clay loam, 2 to 5 percent slopes, eroded
McD2	Marshall silty clay loam, 5 to 11 percent slopes, eroded
MeC2	Mayberry clay, 3 to 9 percent slopes, eroded
MmC2	Monona silt loam, 2 to 5 percent slopes, eroded
MmD2	Monona silt loam, 5 to 11 percent slopes, eroded
MnD2	Monona-Ida silt loams, 5 to 11 percent slopes, eroded
MnE2	Monona-Ida silt loams, 11 to 17 percent slopes, eroded
MnF2	Monona-Ida silt loams, 17 to 30 percent slopes, eroded
MnG	Monona-Ida silt loams, 30 to 60 percent slopes
MpG	Monona-Kipson complex, 30 to 70 percent slopes
MrD2	Morrill clay loam, 5 to 11 percent slopes, eroded
Mv	Moville silt loam, 0 to 1 percent slopes
Nc	Nodaway silt loam, 0 to 1 percent slopes
Nf	Nodaway silt loam, channeled
Ng	Nodaway-Colo silt loams, 0 to 2 percent slopes
Oc	Onawa silt loam, 0 to 1 percent slopes
On	Onawa silty clay, 0 to 1 percent slopes
PaC	Pawnee clay loam, 3 to 9 percent slopes
PbC2	Pawnee clay, 3 to 9 percent slopes, eroded
Pe	Percival-Albaton silty clays, 0 to 2 percent slopes
Pt	Pits, quarries
SaB	Sarpy loamy fine sand, 0 to 3 percent slopes
SbB	Sarpy-Haynie complex, 0 to 3 percent slopes
Sh	Sharpsburg silty clay loam, 0 to 2 percent slopes
ShC	Sharpsburg silty clay loam, 2 to 5 percent slopes
ShC2	Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded
ShD2	Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded
SkD	Shelby clay loam, 5 to 11 percent slopes
SkF	Shelby clay loam, 15 to 30 percent slopes
SvF	Sogn-Kipson complex, 6 to 30 percent slopes
Ud	Udorthents, silty
Wc	Wabash silty clay, 0 to 1 percent slopes
Wd	Wabash silty clay, 0 to 1 percent slopes, depressional
Wt	Wymore silty clay loam, 0 to 2 percent slopes
WtC	Wymore silty clay loam, 2 to 7 percent slopes
WyC2	Wymore silty clay, 2 to 7 percent slopes, eroded
Zh	Zoe-Zook silty clay loams, 0 to 1 percent slopes
Zk	Zook silt loam, 0 to 1 percent slopes
Zo	Zook silty clay loam, 0 to 1 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Reservation (national forest or park, state forest or park, and large airport)
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, — Davis Airstrip

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Federal
- State
- County, farm or ranch

RAILROAD

LEVEES

- Without road

DAMS

- Medium or small — water

PITS

- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Located object (label) — Tower

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
- Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water
- Intermittent

MISCELLANEOUS WATER FEATURES

- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — PaC WyC2

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

MISCELLANEOUS

- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Rock outcrop (includes sandstone and shale)
- Sandy spot
- Severely eroded spot
- Stony spot
- Glacial till spot
- Reddish Brown loess spot

NEMAHA COUNTY, NEBRASKA NO. 1

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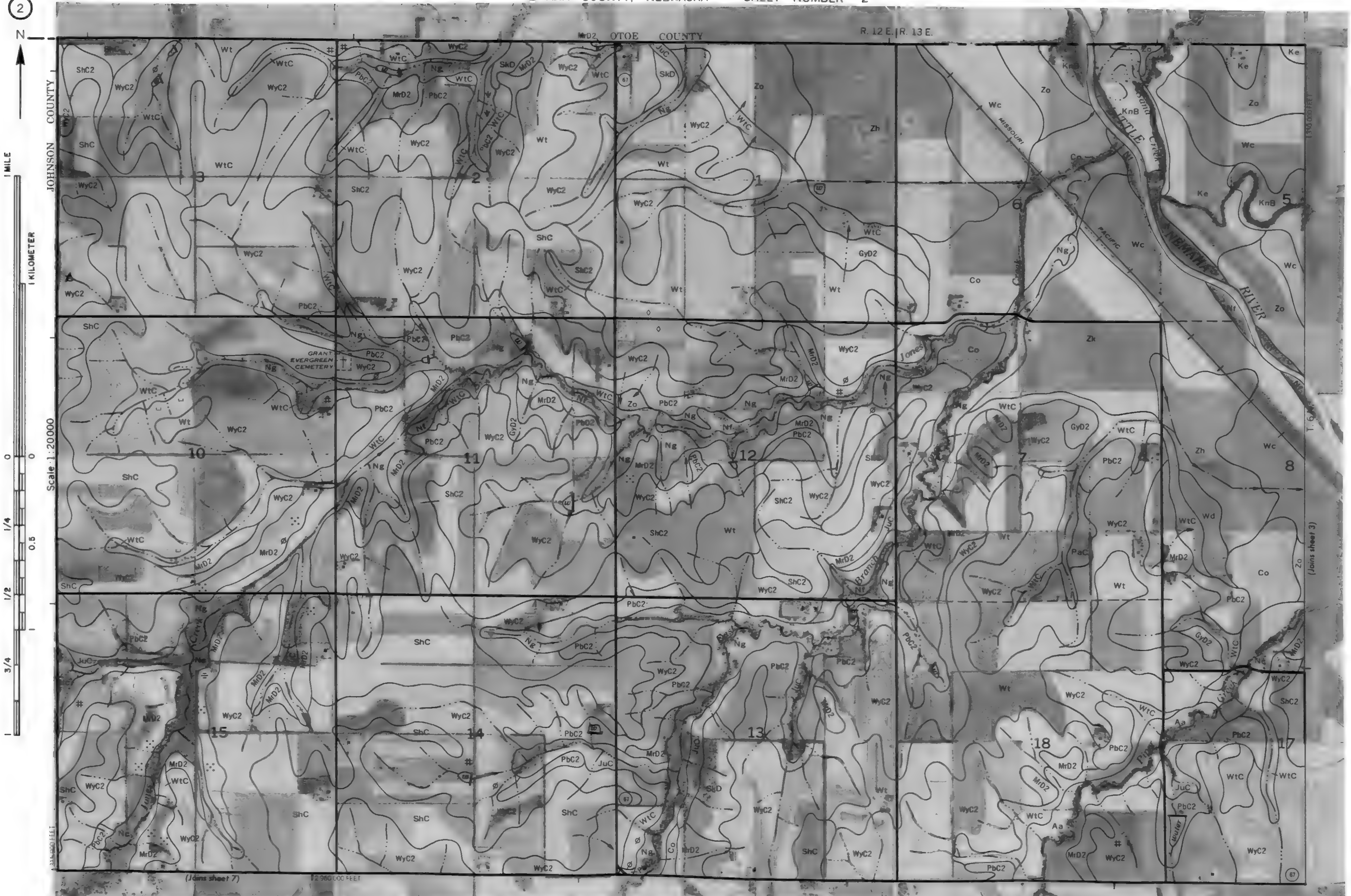

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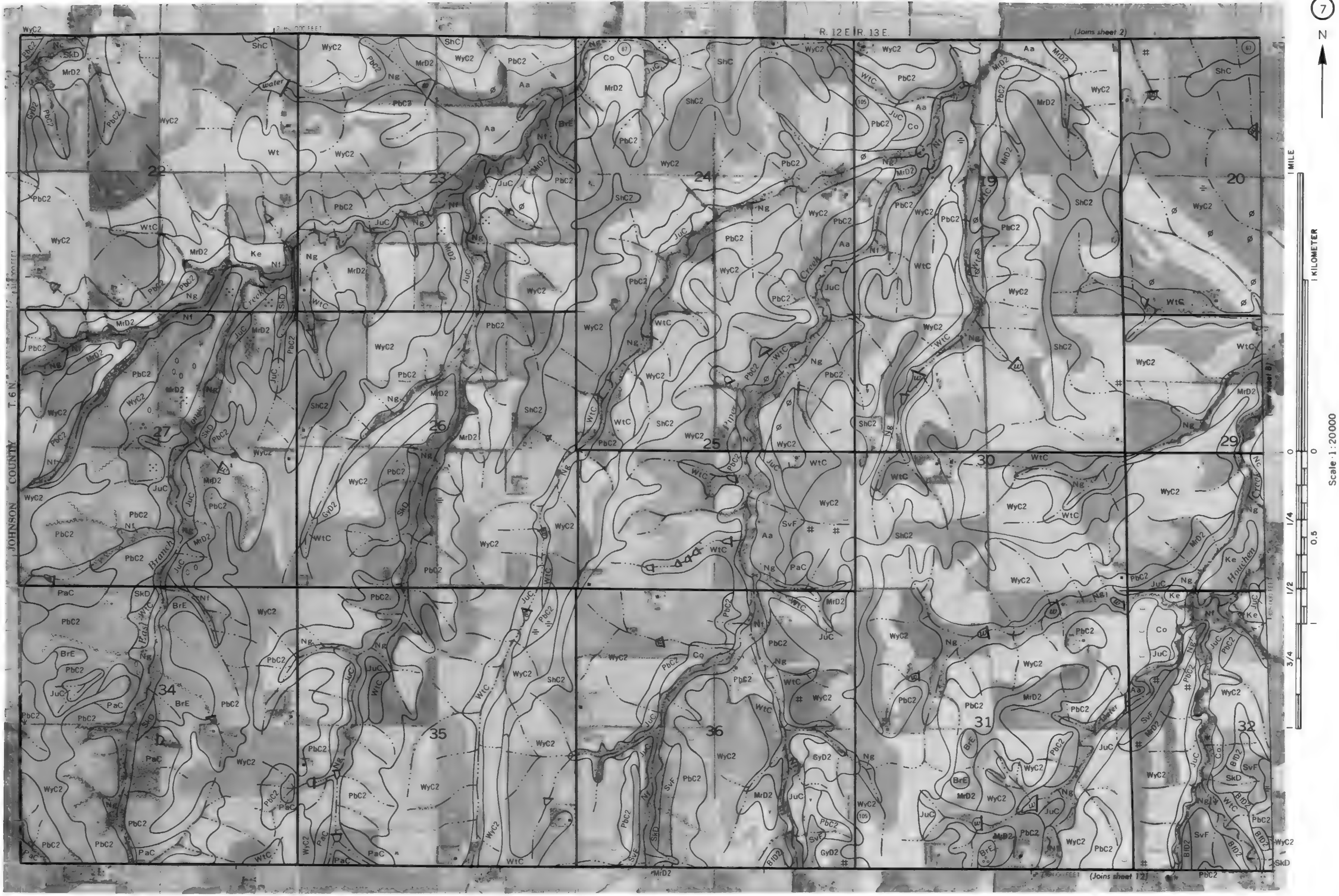

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NEMAHA COUNTY, NEBRASKA NO. 8

9

NEMAHA COUNTY, NEBRASKA NO. 9

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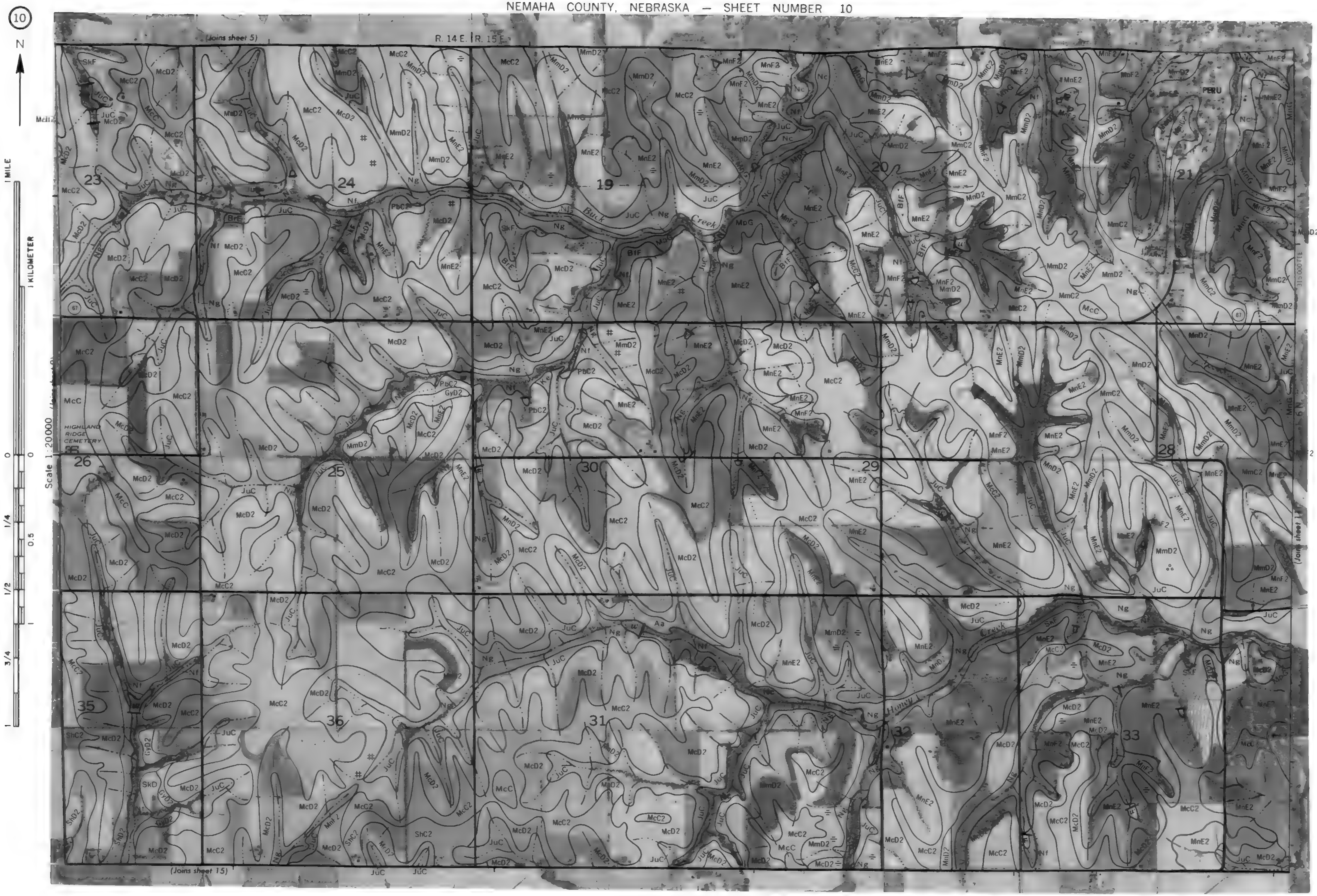
N

1 MILE

1 KILOMETER

Scale 1:20000



NEMAHA COUNTY, NEBRASKA NO. 10

(11)

N

Scale 1:20000

0 1/4 1/2 3/4 1 MILE

0 0.5 1 KILOMETER

NEMAHA COUNTY, NEBRASKA NO. 11

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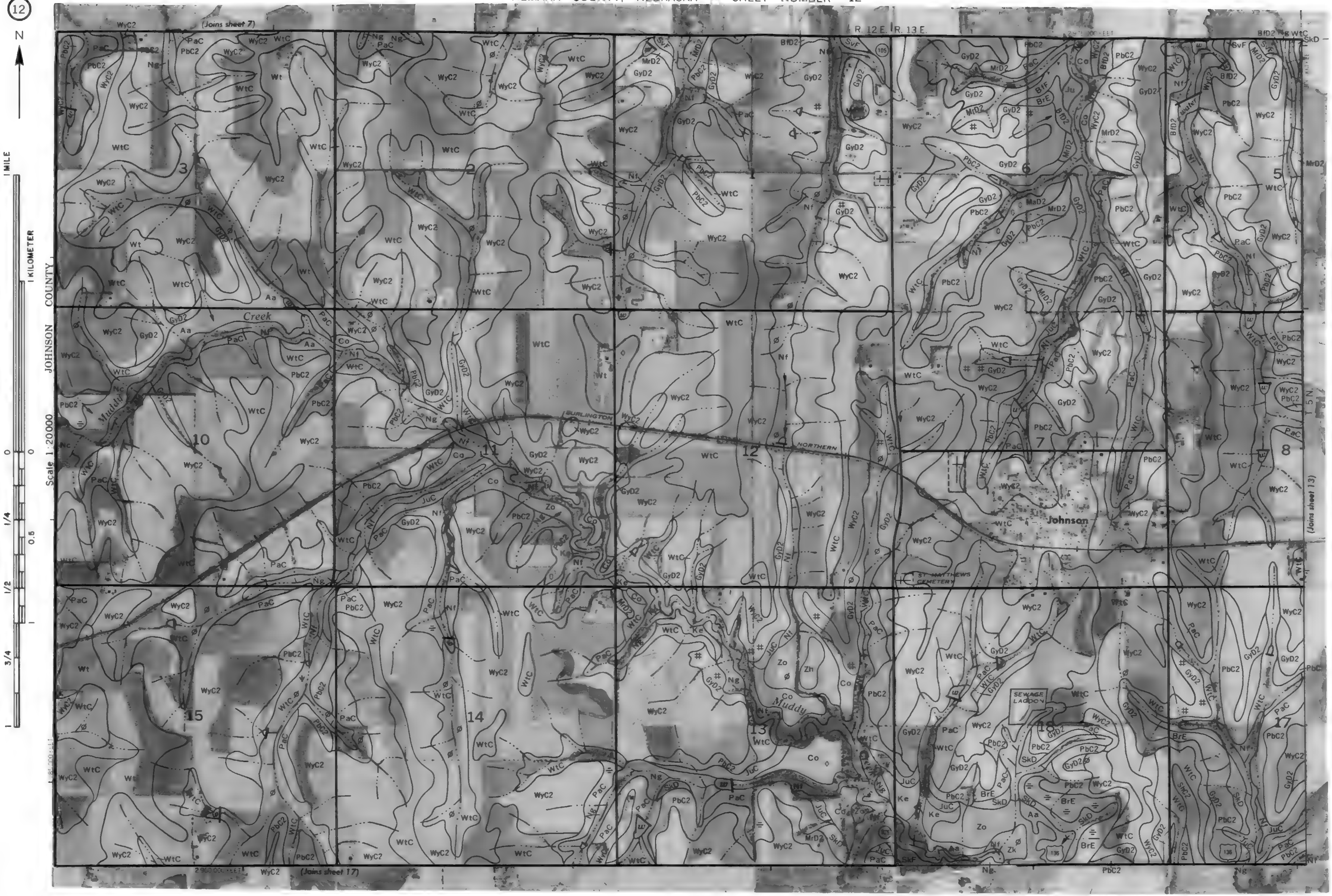
NEMAHA COUNTY, NEBRASKA — SHEET NUMBER 12



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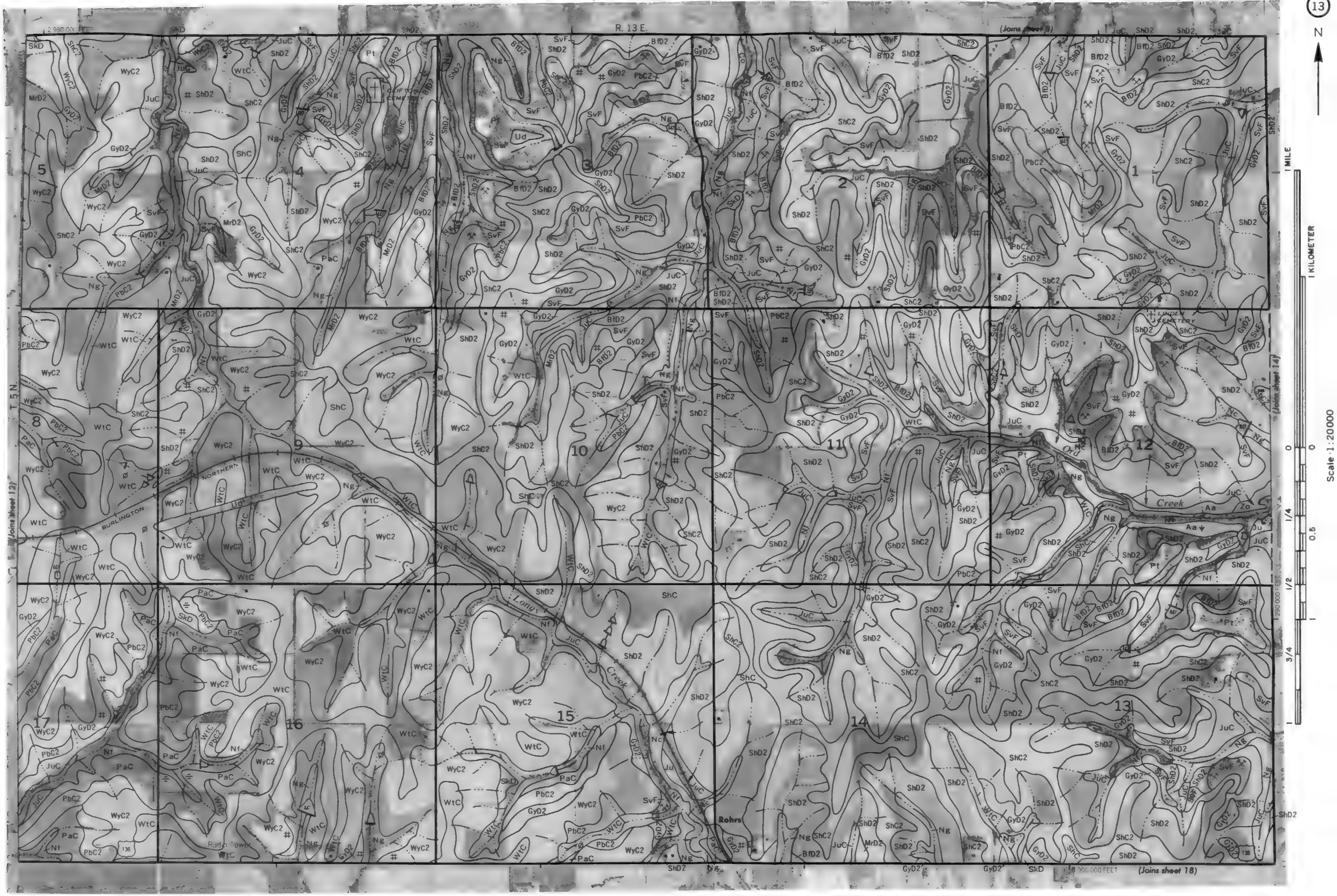

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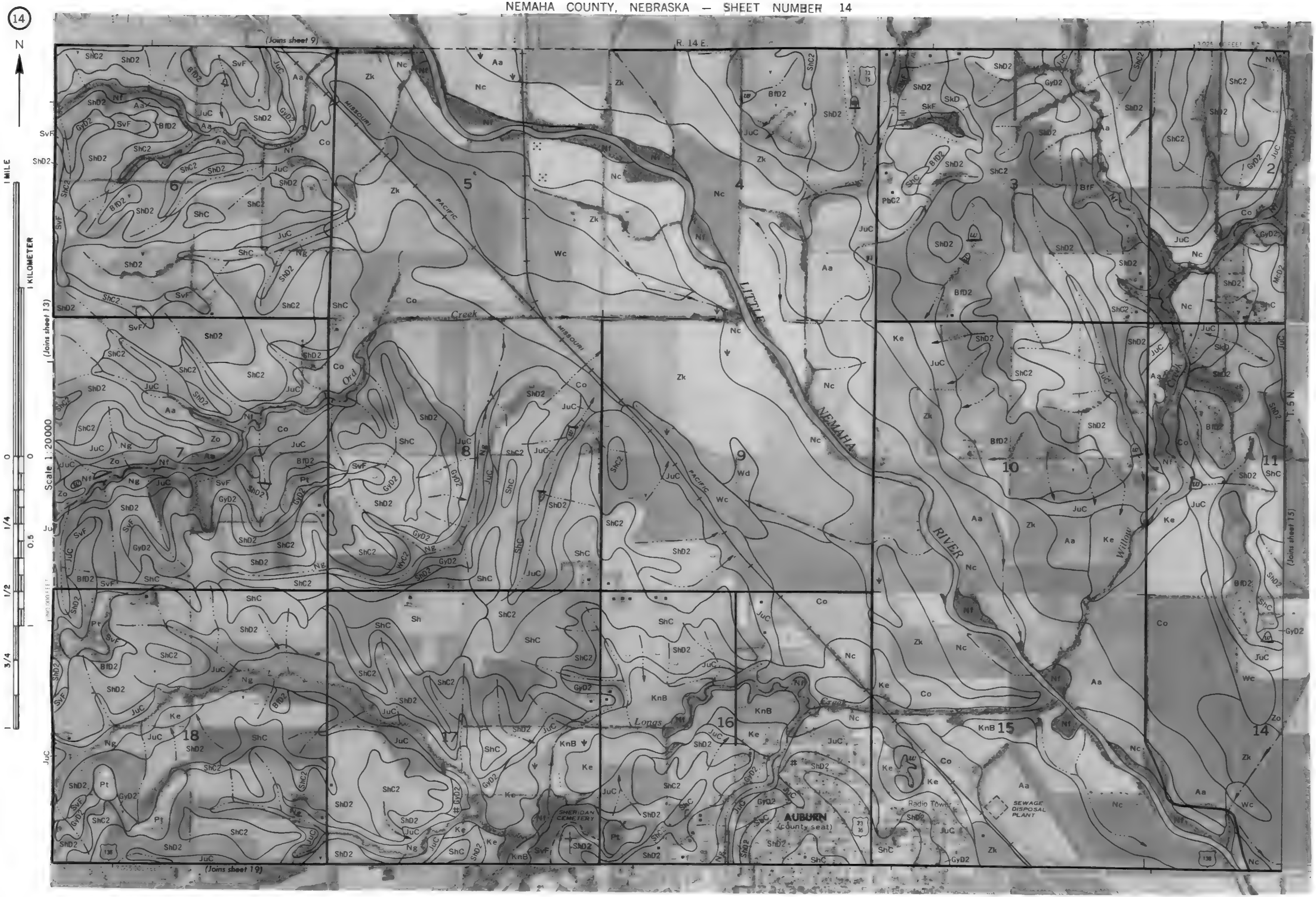

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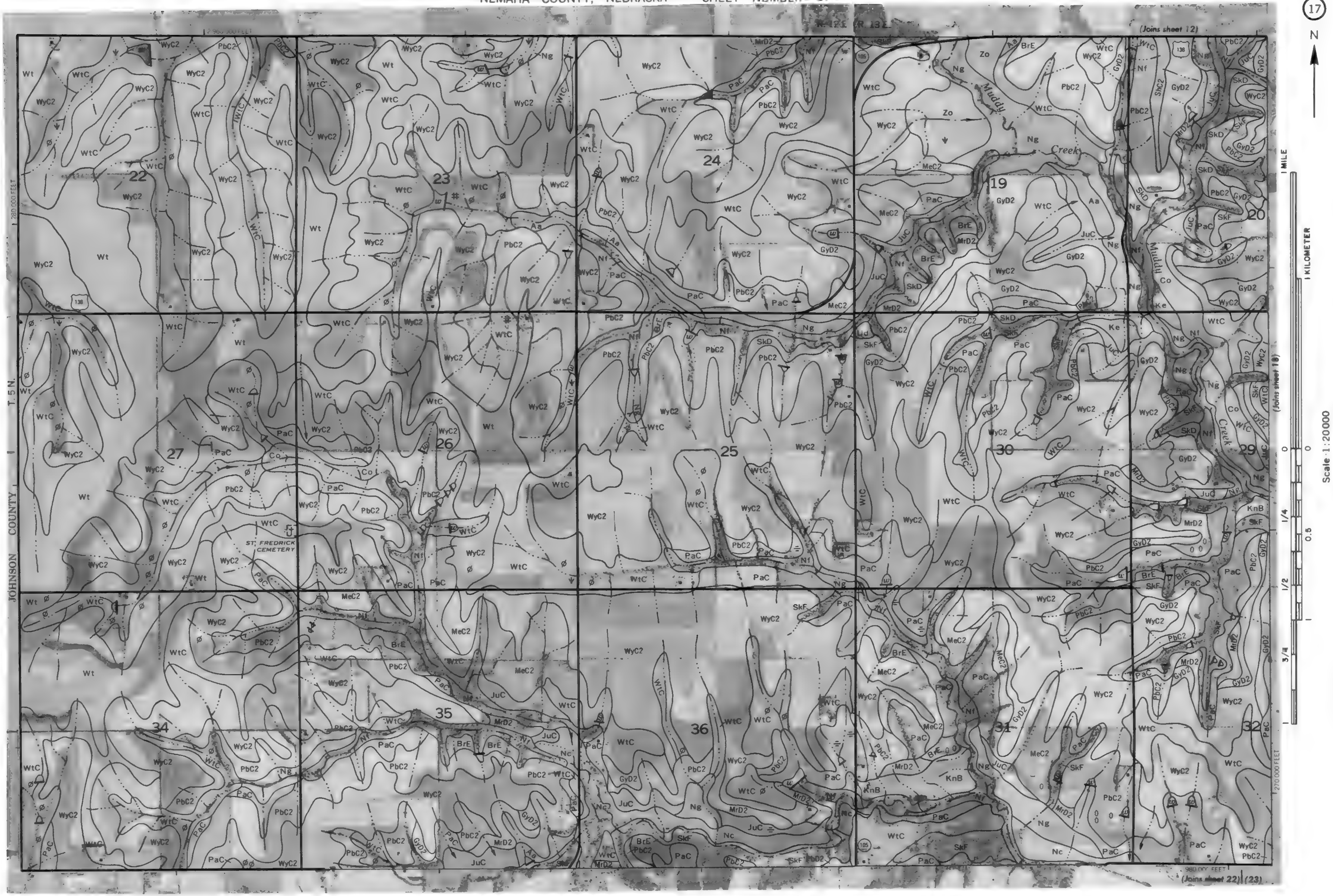

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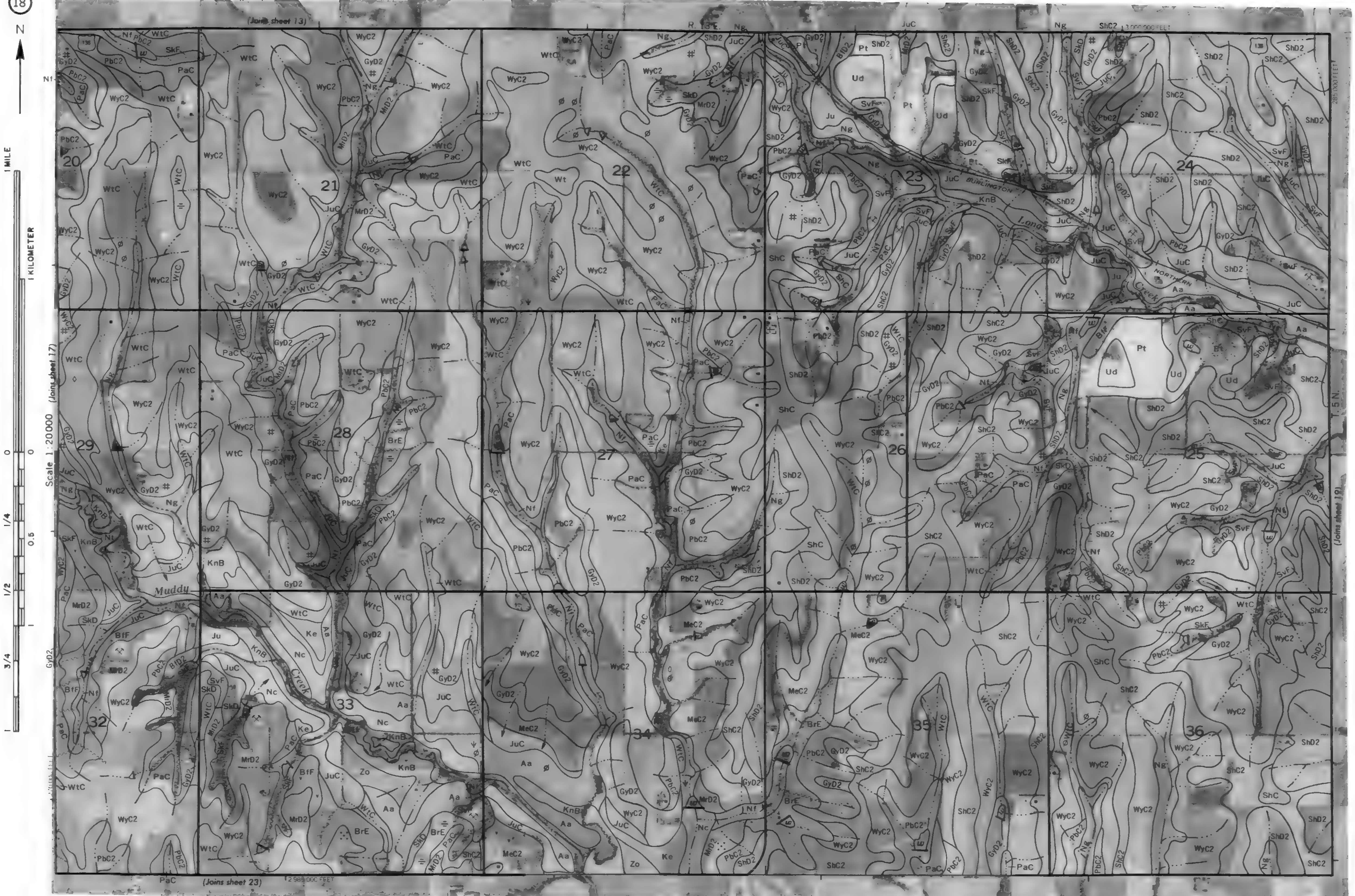

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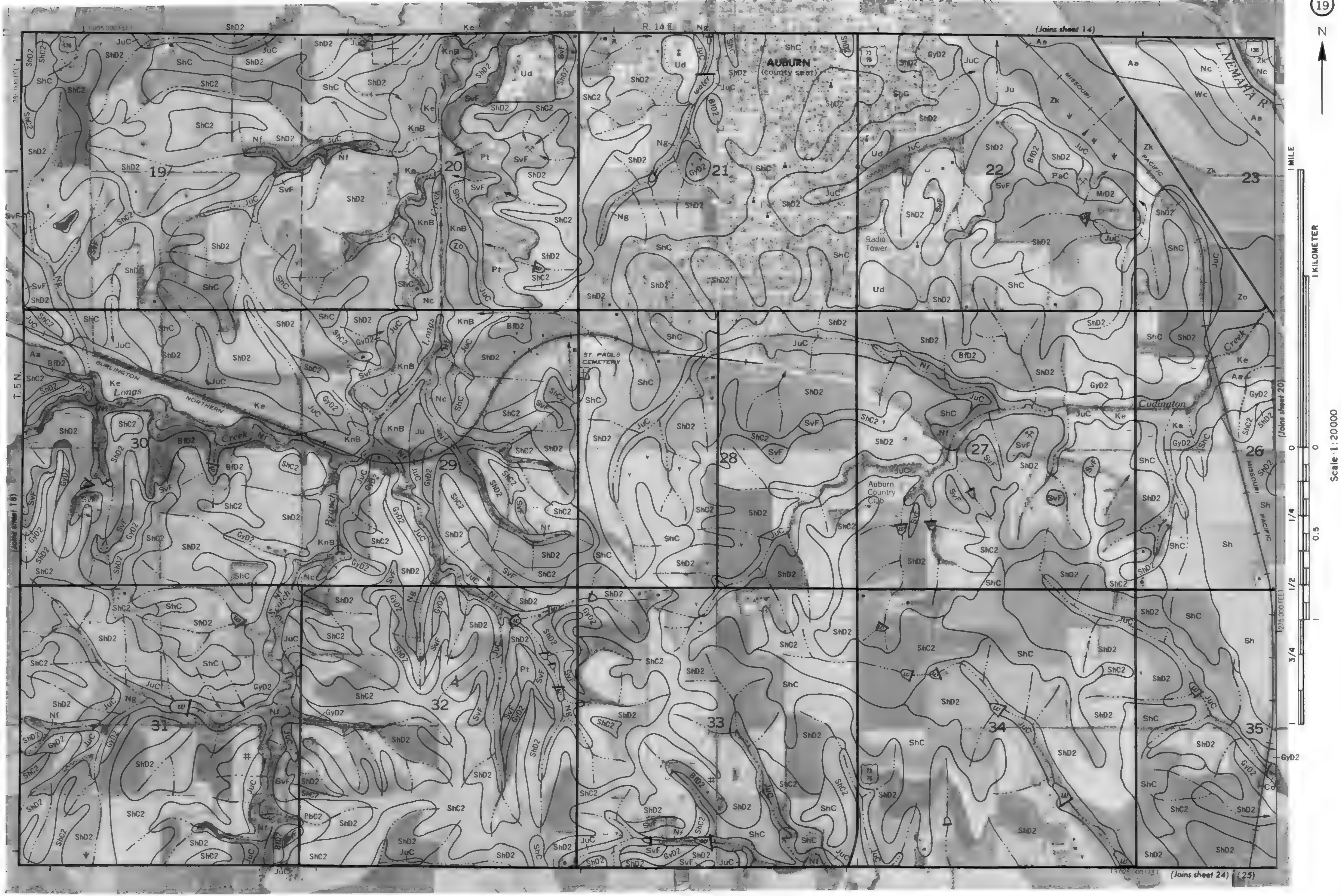

NEMAHA COUNTY, NEBRASKA NO. 19

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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NEMAHA COUNTY, NEBRASKA NO. 21

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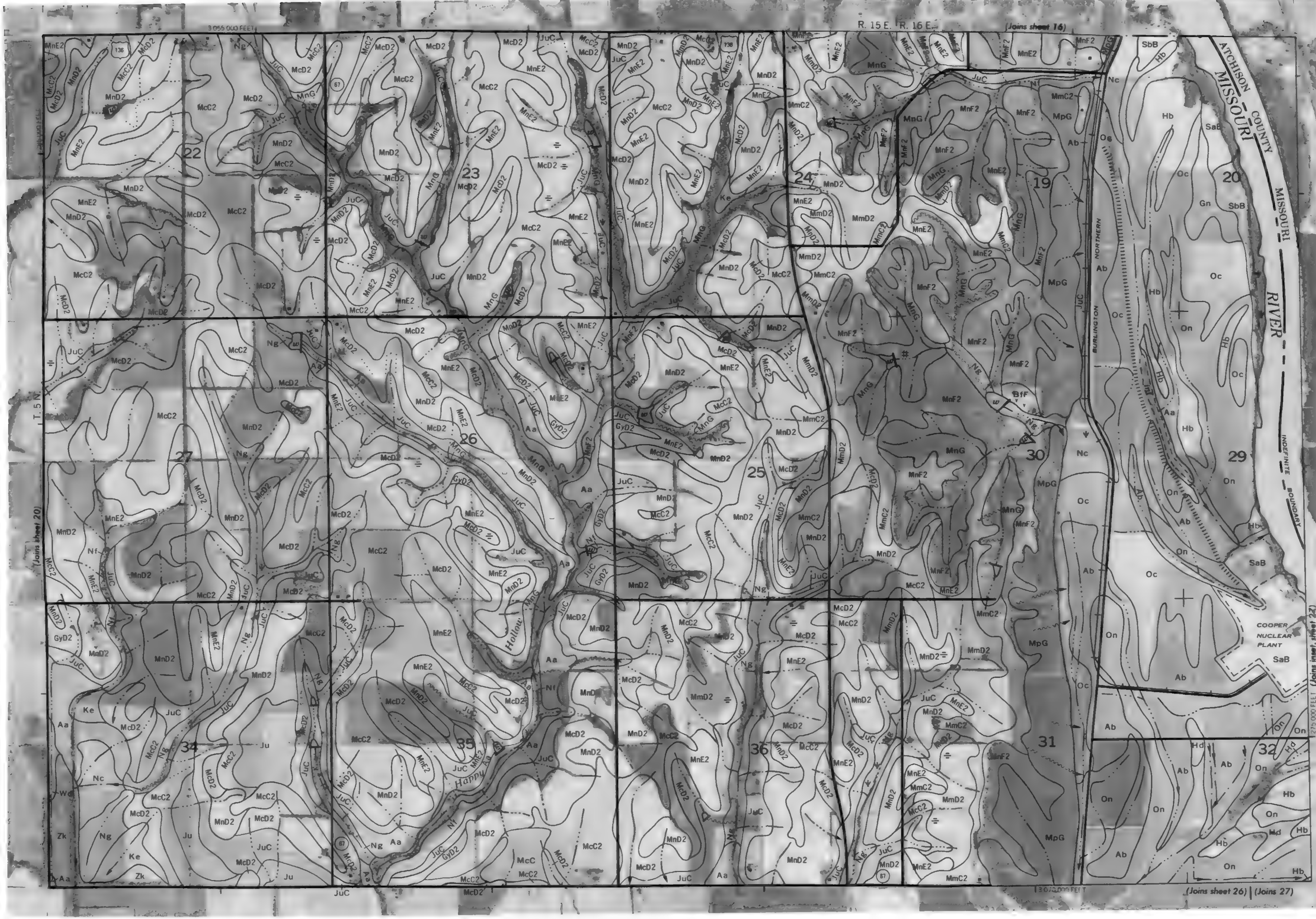

N

1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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NEMAHA COUNTY, NEBRASKA NO. 22

23

NEMAHA COUNTY, NEBRASKA NO. 23

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

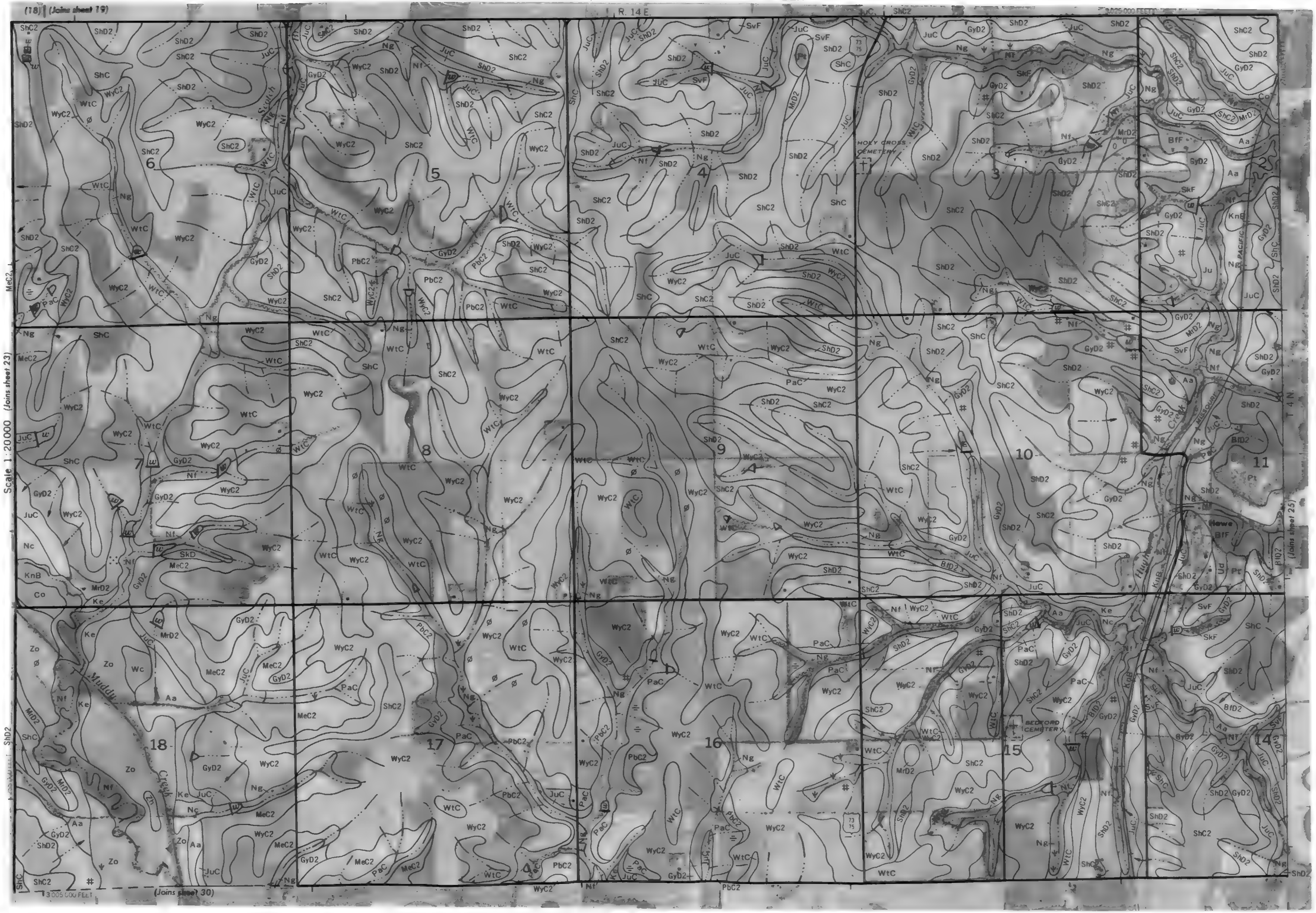
24

N

1 MILE

1 KILOMETER

Scale 1:20000



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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NEMAHA COUNTY, NEBRASKA NO. 24

(25)

NEMAHA COUNTY, NEBRASKA NO. 25

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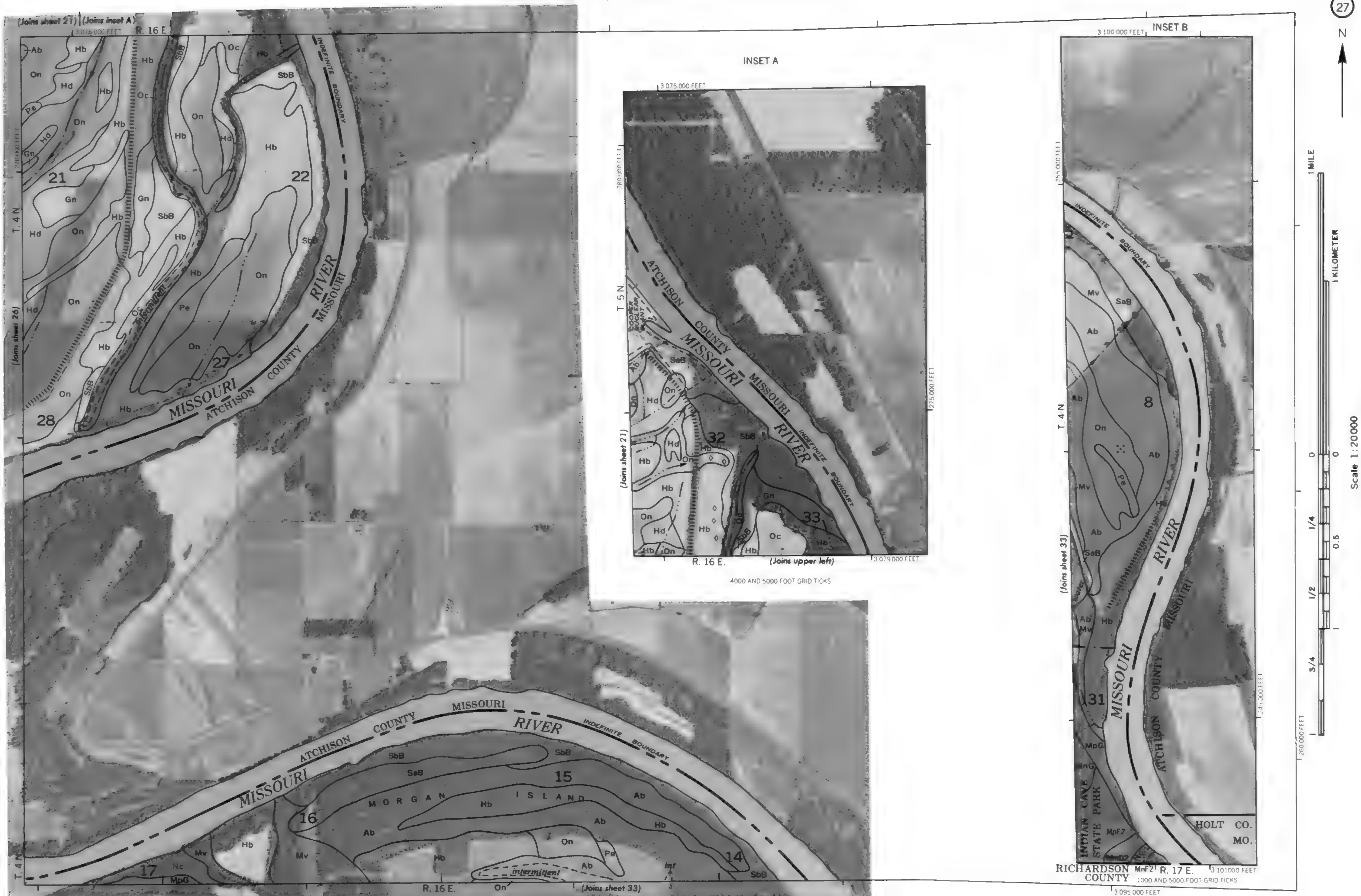
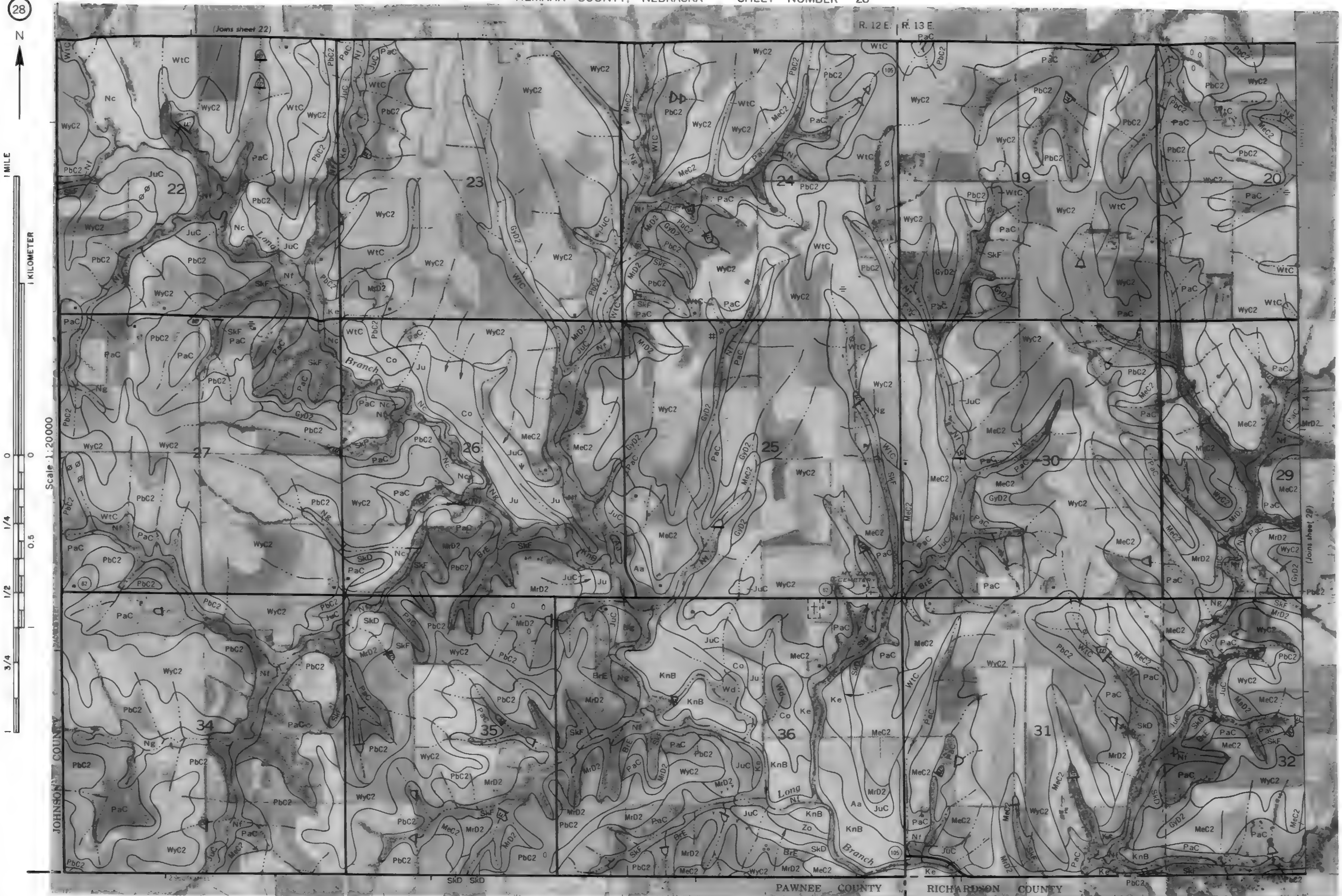
NEMAHA COUNTY, NEBRASKA NO. 26

NEMAHA COUNTY, NEBRASKA NO. 27

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



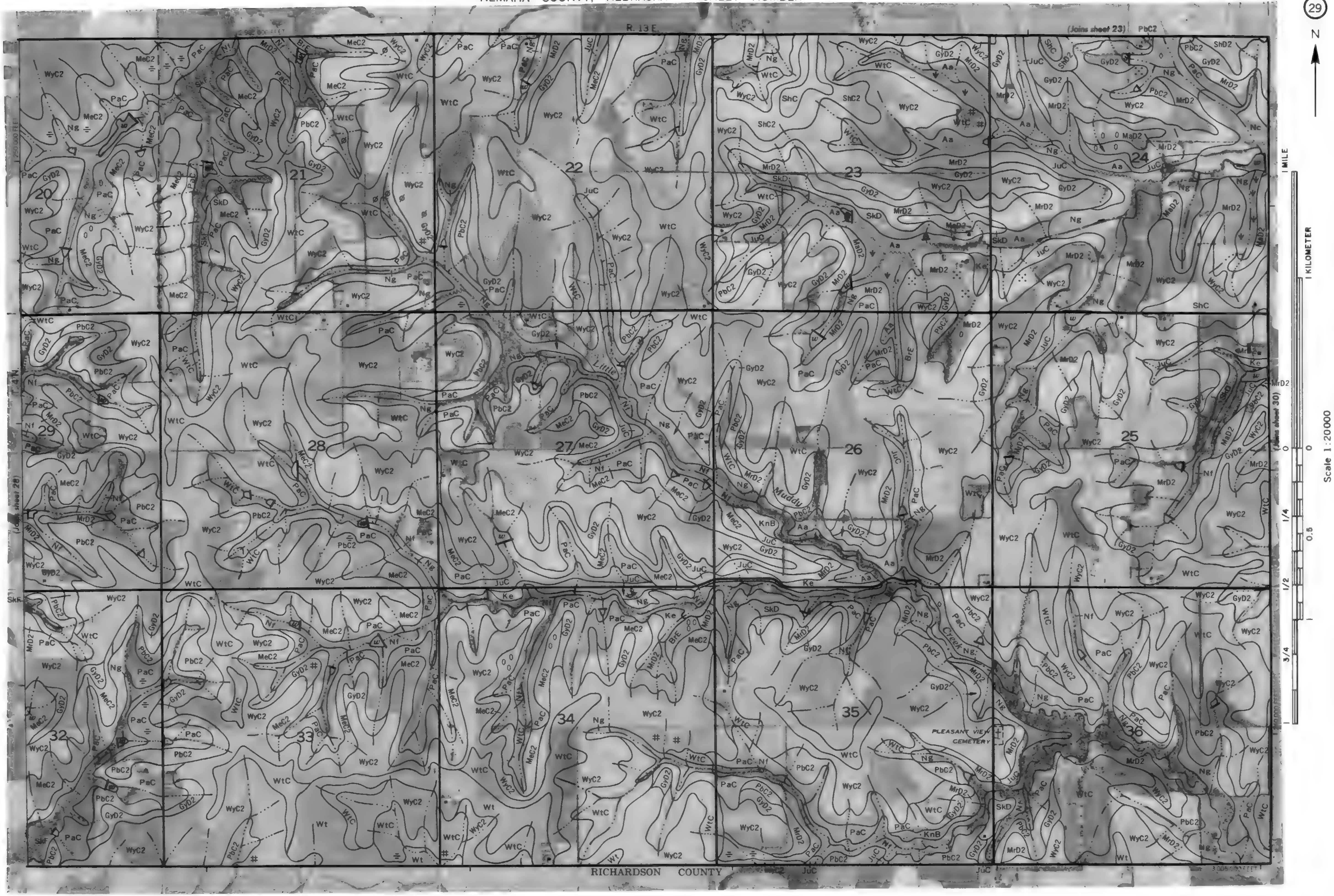
NEMAHA COUNTY, NEBRASKA — SHEET NUMBER 28



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

NEMAHA COUNTY, NEBRASKA NO. 28

NEMAHA COUNTY, NEBRASKA — SHEET NUMBER 29



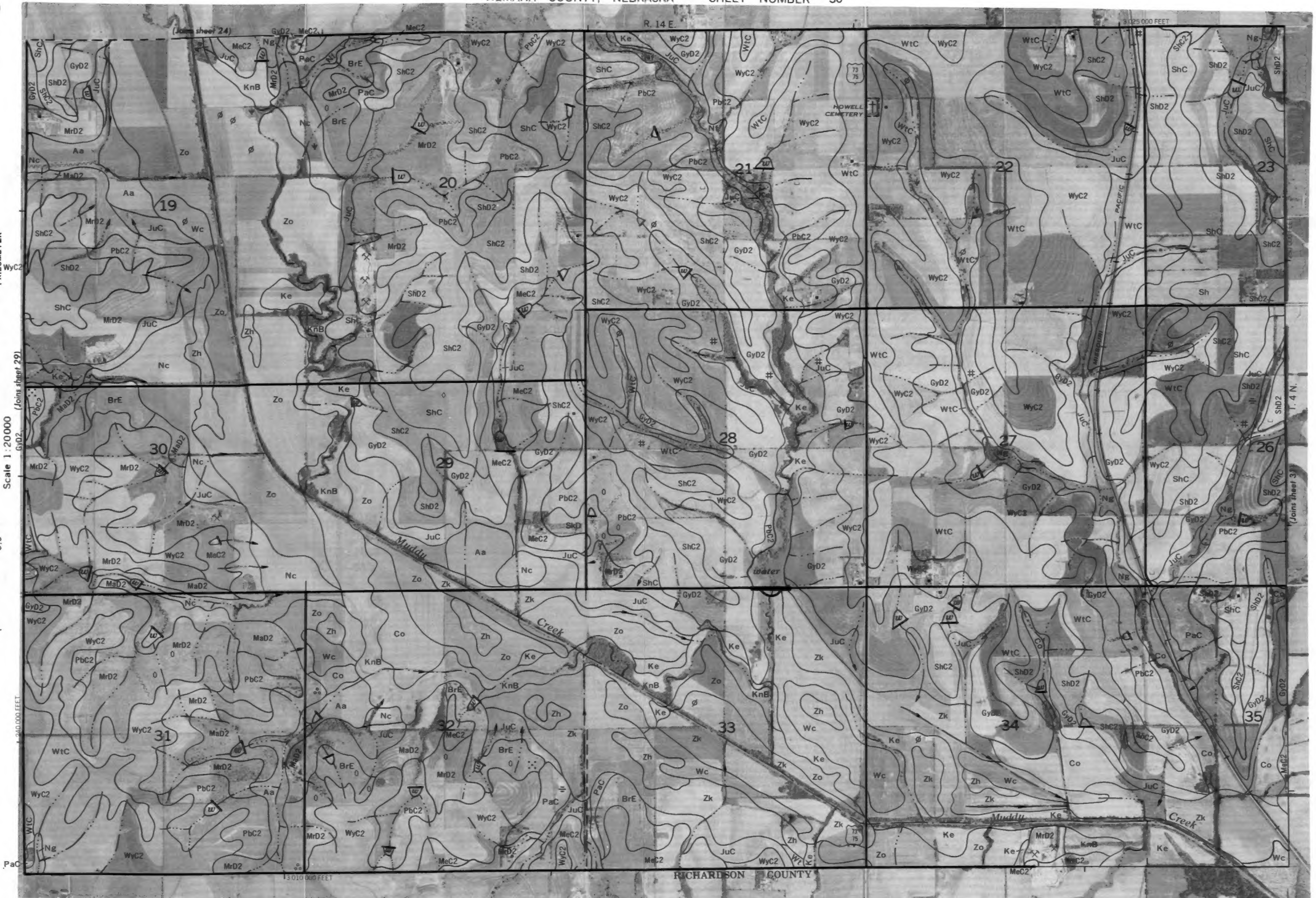
NEMAHA COUNTY, NEBRASKA NO. 29

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(30)

NEMAHA COUNTY, NEBRASKA — SHEET NUMBER 30

N



1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

NEMAHA COUNTY, NEBRASKA NO. 30

NEMAHA COUNTY, NEBRASKA NO. 31

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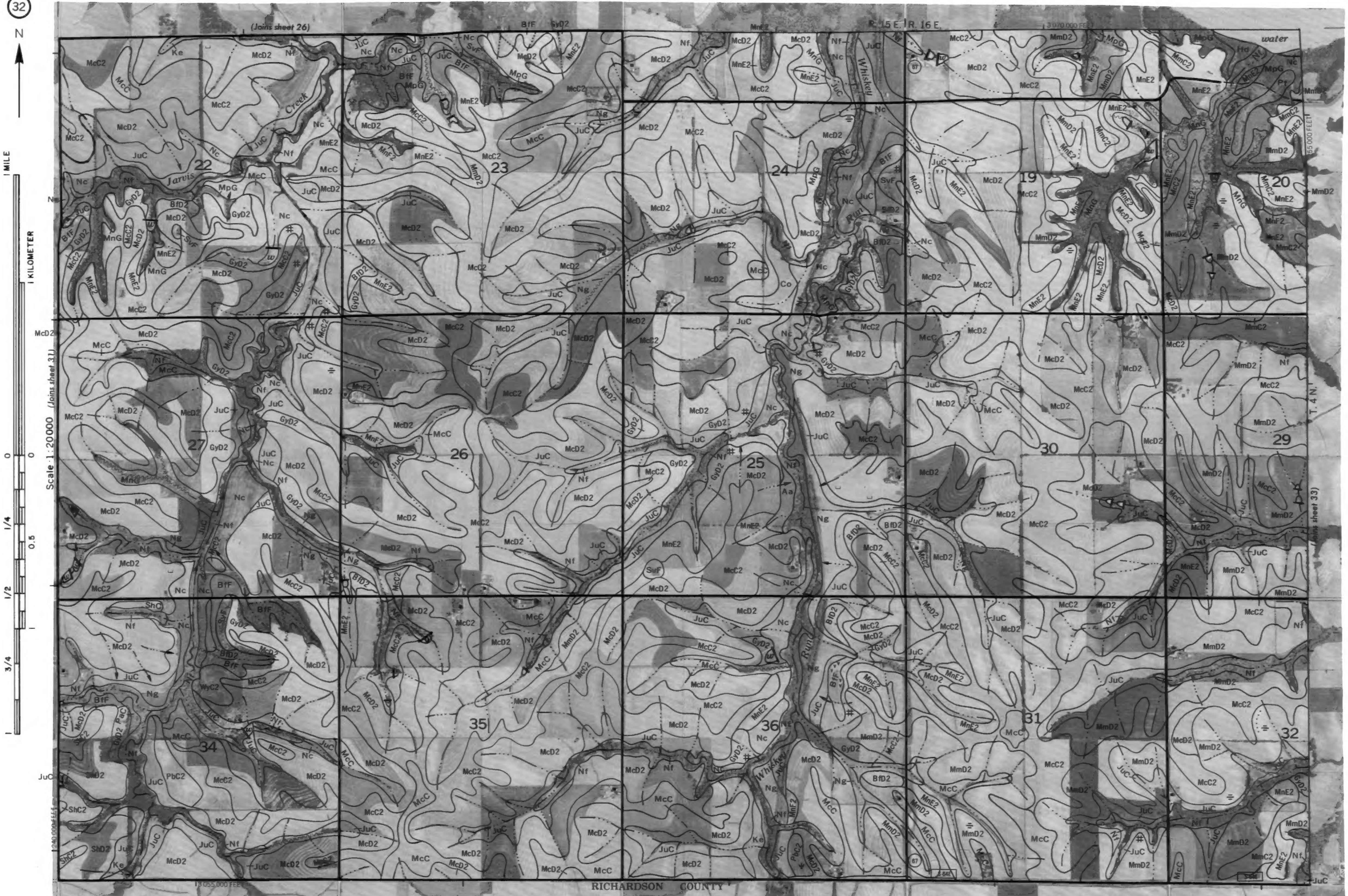
NEMAHA COUNTY, NEBRASKA — SHEET NUMBER 32



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

NEMAHA COUNTY, NEBRASKA NO. 33

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